Engineering Library

JAN 30 1935


# The Engineer

ESTABLISHED 1856. REGISTERED AS A NEWSPAPER.

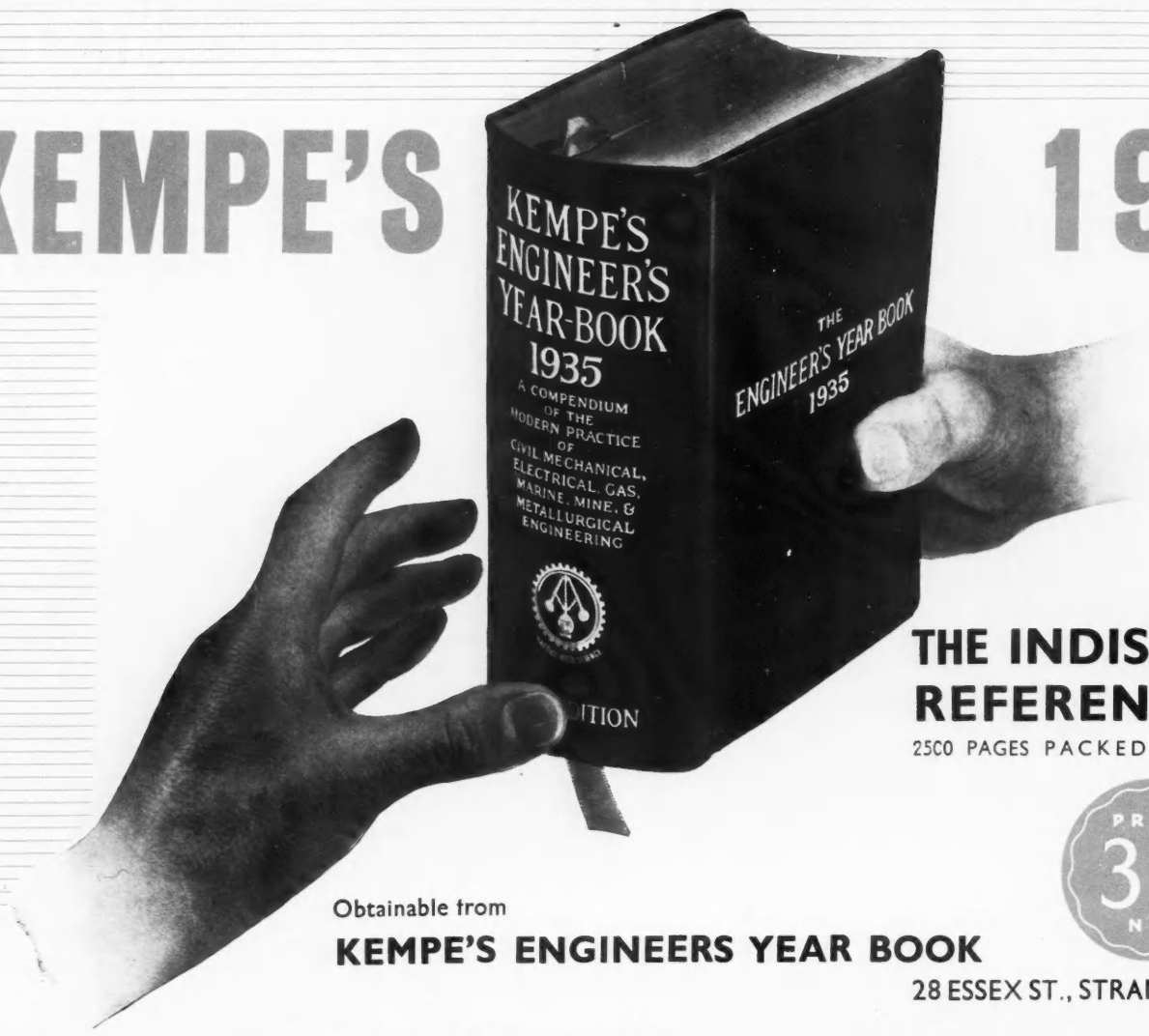
VOL. CLIX.—No. 4123] 28, ESSEX ST., LONDON, W.C. 2. [JANUARY 18, 1935

BRUSSELS EXHIBITION BUILDING during construction. The foundations—and for that matter the whole contract—were carried out by ENGEMA, licensees for the Rotinoff system in Belgium.
THIS BUILDING
STANDS ON ROTINOFF
RAKER SHELL PILES
WEST'S ROTINOFF PILING & CONSTRUCTION CO., LTD.,
REGENT HOUSE, KINGSWAY, LONDON, WC2

*A booklet which gives tabulated information relating to a large number of varied Rotinoff contracts will be sent on request.*

Raymond

# KEMPE'S 1935




**THE INDISPENSABLE REFERENCE BOOK**

2500 PAGES PACKED WITH INFORMATION

PRICE 31/6 NET

Obtainable from

**KEMPE'S ENGINEERS YEAR BOOK**

28 ESSEX ST., STRAND, LONDON, W.C.2.

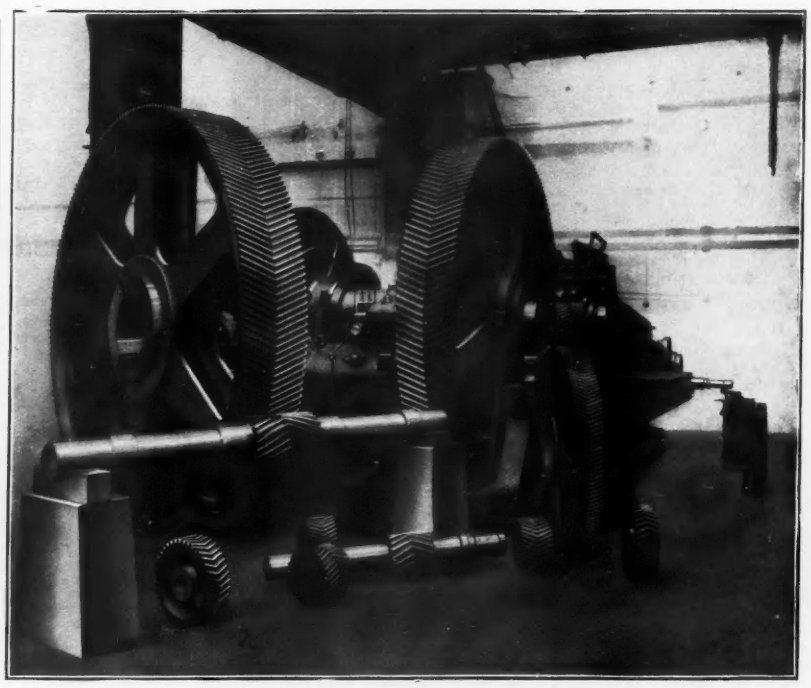
and all Booksellers.

# GEARS FOR ALL PURPOSES

GEARS MUST NOT BE MERELY EFFICIENT, BUT SAFE.

THIS MEANS STURDY CONSTRUCTION, UNIMPEACHABLE MATERIAL ACCURACY IN MACHINING AND CUTTING OF THE TEETH.

STEEL BLANKS AND GENERAL STEEL CASTINGS ARE PRODUCED IN OUR OWN FOUNDRIES AND EVERY STAGE IN THE DESIGN AND MANUFACTURE IS UNDER THE CONTROL OF ENGINEERS WHO HAVE AN INTIMATE KNOWLEDGE OF MODERN GEARING REQUIREMENTS.



DOUBLE HELICAL GEARS WITH GENERATED TEETH.
GREAT ACCURACY IS ESSENTIAL FOR HIGH SPEED REQUIREMENTS.

CONSULT

**P. R. JACKSON & Co. LTD.** SALFORD ROLLING MILLS, MANCHESTER

# A Seven-Day Journal

## Central Electricity Board.

THE Central Electricity Board announces that it has appointed Mr. Harold Hobson, M.I.E.E., Assoc. M. Inst. C.E., to be the Board's General Manager in succession to Sir Archibald Page, who is now the chairman of the Board. Mr. Hobson, who is forty-three years of age, has been the commercial manager of the Central Electricity Board for the past seven years. He is the son of Mr. J. A. Hobson, the well-known economist, and he received his technical education at King's College, London, where he took his B.Sc. degree. He first became associated with the electricity industry as assistant engineer with the firm of Messrs. Merz and McLellan, consulting engineers, in Middlesbrough and Darlington, and in 1919 was transferred to its London office, taking charge, on behalf of the firm, of the construction of the first section of the Barking generating station. On the completion of that work, he became the joint manager of the County of London Electric Supply Company, Ltd., a position he occupied for three years, during which time he was responsible for the negotiation of a number of bulk supply and large power contracts. Mr. Hobson, who joined the Central Board in March, 1928, has thus had over twenty years' experience of the engineering and commercial aspects of the electricity supply industry.

## A South African Empire Exhibition.

AN Empire Exhibition, which will include a comprehensive industrial and machinery section, will be held in Johannesburg during the concluding months of 1936, from October, 1936, to January, 1937. The Exhibition has the approval and strong financial support of the Government of the Union of South Africa, and the City of Johannesburg, which, at the time, will be holding its Jubilee celebrations, has given a guarantee equal to the Government grant. The Exhibition will be organised by a registered association under the control of an executive committee appointed by a highly representative general committee. This committee will consist of nominees of the City of Johannesburg and of other cities, such bodies as the Chamber of Mines, Chambers of Commerce and Industry, and of all bodies and institutions in South Africa contributing to or representative of the public life of the country. The general manager of the Exhibition will be Mr. B. M. Bellasis, the head of the exhibitions section of the Federation of British Industries. Mr. Bellasis was the general manager of the British Trade Exhibition in Buenos Aires in 1931, and since the war he has been connected with the organisation of similar exhibitions in Greece, New Zealand, Canada, Australia, Palestine, Denmark, and other Continental countries. In the United Kingdom the Exhibition will be represented by the Federation of British Industries, assisted by a small advisory committee of gentlemen intimately connected with South Africa and her interests.

## The Late Mr. John Alexander.

AN outstanding figure in Clyde marine engineering has been lost by the death of Mr. John Alexander, director and general manager of Barclay, Curle and Co.'s marine engine and boilermaking department, which took place at his home, Earleseat, Scotstoun, Glasgow, in the early part of last week. With the exception of two years spent at Belfast, Mr. Alexander had been associated throughout his whole business career with Barclay, Curle and Co., Ltd. For over eighteen years he held the position of engineering general manager, and four years ago he was appointed to the board of directors. Along with Mr. Archibald Gilchrist, the late chairman of the company, Mr. Alexander played an important part in the introduction of the marine internal combustion engine for propulsion and auxiliary work. He was assistant to Mr. Gilchrist in 1912, when his firm built and engined the first ocean-going twin-screw motor ship "Jutlandia" to be constructed in Great Britain. His long experience with internal combustion engines, particularly with the Doxford type of opposed piston engine and with modern steam machinery, gave him an authoritative place among Clyde marine engineers.

## The Coal-Burning Appliance Makers' Association.

SOME time ago we made a brief reference to the proposed Coal Burning Appliance Makers' Association, which has now been formed under the chairmanship of Mr. H. Teeling-Smith, and already includes the leading manufacturers of steam-raising plant and all appliances for the burning of solid fuel. The programme of activities just announced includes a wide scale of operations. The Association has been divided into sections and it covers the entire field of coal-burning appliances: domestic and central heating and cooking; steam raising for public utility, industrial and marine purposes; traction; and process heating in the metallurgical, chemical, calcining, and other industries. It also has a fully representative technical sub-committee. Its aim is to represent the common interest of members and strengthen their position in their relations with producers and distributors of coal and coke and with consumers. Liaison with the Coal Utilisation Council has been established by representation on the Marine Fuel Committee of the Council and through the Chief Engineer of the C.U.C., who is a co-opted member of the technical sub-committee of the Association. In addition to the preparation and issue of detailed schedules of appliances and their makers, the Association will watch legislation in the interests of its members. It will offer recommendations in respect of guarantees and warranties, arbitrate between member firms and arrange the settlement of differences with customers, and co-ordinate and protect members' interests with relation to trade shows and exhibitions. Its technical sub-committee programme includes standardisation of nomenclature, of ratings and methods of testing; the investigation of the effect of coal grading and classification on efficiency; research into combustion, heat utilisation and the mechanics of coal-burning appliances, and the collection and collation of data with regard to the performance of these appliances and the factors affecting their operation. Membership of the Association confers the right to advance copies of papers and confidential reports, and, as soon as it can be arranged, to tests of types of appliances and certificates of efficiency. A directory of appliance manufacturers is also to be prepared and published.

## L.P.T.B. Wages.

ON Thursday last, January 10th, the London Passenger Transport Board issued an official statement with regard to the successful settlement of the wage negotiations and conditions of employment of the staffs of the underground and tube railways. The settlement of the wage claim of the underground railwaymen provides that from the first full pay period after April 1st the percentage deductions of 2½ per cent. from all earnings at present operating shall be reduced to 1½ per cent., and that from the first full pay period after June 1st all percentage deductions from earnings shall cease. In the statement, which is signed by Lord Ashfield, the chairman of the company, an appeal is made to the staff to co-operate with the company in its efforts to make the services increasingly popular with the travelling public, and thereby secure that additional patronage which will help the company to meet the additional working costs which the concessions made will inevitably bring about. The Board is to be congratulated on the success which has met its efforts to settle the many problems affecting a staff of close upon 76,000 persons. Many anomalies, both as regards wages and conditions of service, have now been removed, wage disparities adjusted, and effect given to agreements and promises entered into by undertakings before they were transferred to the Board.

## A British Aircraft Development Scheme.

THE announcement is made that an important development in British aircraft construction is, after long negotiations, now practically completed, and that a definite statement may be made in a few weeks' time concerning the construction of a new aircraft factory, probably at Newcastle-upon-Tyne. Some time ago we announced that the Wallsend firm of Swan, Hunter and Wigham Richardson, Ltd., shipbuilders and marine engineers, had acquired an active interest in the aircraft manufacturing business of Airspeed, Ltd., of Portsmouth. It is now stated that the two British firms have secured the services of Mr. Antony Fokker, the Dutch aircraft designer and builder in an advisory capacity. An agreement has been reached under which the British firms will acquire the licence to manufacture existing types of Fokker machines and other types for which Mr. Fokker holds the licence. These include the American Douglas machine. The Fokker machines or machines designed jointly by Mr. Fokker and Airspeed, Ltd., will be built either at Portsmouth or at the new factory. The scheme is expected to take practical shape in about a month's time.

## The Iraq Pipe Line.

ON Monday, January 14th, at Kirkuk, his Majesty King Ghazi of Iraq formally opened the Iraq-Mediterranean oil pipe line, which has been completed by the Iraq Petroleum Company, Ltd. The ceremony marked the first of a series which will take place at different parts of the undertaking. Those present included Sir John Cadman, the chairman of the Iraq Petroleum Company, Ltd.; Sir Francis Humphrys, the British Ambassador; and a large and international gathering representative of the many interests concerned. After inspecting the buildings and quarters, King Ghazi entered the pump house and by turning an air valve started the oil engines driving the pumps, thus sending oil on its 600-mile journey across the desert to the Mediterranean Sea. At the luncheon which followed, Sir John Cadman, in proposing King Ghazi's health, emphasised the cordial assistance which had been received from the Iraq Government in the construction and operation of the pipe line. The King, in reply, spoke in keen appreciation of the technical and administrative methods by which the Iraq Petroleum Company had surmounted the difficulties of its task. He expressed pleasure that his countrymen had taken an important share in the work and had profited by the training they had received in the company's service, and further expressed the hope that they might thus benefit on an increasing scale as the company made further calls for oil. Iraq, he said, depended on her oil resources to provide the means of the country's further development and progress. Elsewhere in this issue we begin our description of the pipe line system.

## Road Transport Legislation.

IT has been known for some time that the system of testing of new drivers will come into action on April 1st next. The announcement has now been made that the Minister of Transport has decided also to bring into force the speed limit in built-up areas, provided for in the Road Act. Regulations with regard to the necessary traffic signs were made by the Minister last week, and after March 18th next there will be a speed limit of 30 m.p.h. in built-up areas. At the same time that this announcement was made the decision to extend the system of pedestrian crossing-places to districts outside London was taken. There has, it is said, been an insistent demand from the rest of the country for the extension of the system, and in some cases Councils, in anticipation of the approval of the Minister, have already laid down crossings. A circular letter is to be addressed to those authorities which have not so far submitted schemes to the Minister, informing them of his desire to see crossings provided where necessary throughout the country. In future all pedestrian crossings will be marked in accordance with the regulations laid down and experiments with other methods of marking will only be made with the express concurrence of the Minister. In a statement issued on Tuesday, January 15th, the Royal Automobile Club urged delay in the introduction of the new speed limit of 30 m.p.h. in built-up areas, until there had been an opportunity to estimate the various safety values of the numerous experiments which are now being carried out.

## Engineering Overseas.

AT a meeting of the Royal Empire Society held on Tuesday evening, January 15th, Sir Clement Hindley, formerly the Chief Commissioner of Indian Railways, presided over a symposium dealing with the pioneer work of British engineers overseas. In introducing the speakers Sir Clement said that whatever historians might say of the political or economic reasons for colonisation and dominion, the motive which had always actuated the man on the spot responsible for administration and government had been the desire to advance human conditions of life. The engineer had been the instrument by which that improvement had been effected. Mr. Ralph Freeman, who designed Sydney Harbour Bridge, gave an interesting account of its design and construction, and paid a tribute to the work of Dorman, Long and Co., Ltd., and its general manager in charge of the bridge, Mr. Lawrence Ennis. Mr. Julian Tritton said that one of the outstanding features of Indian railways was standardisation, a policy initiated forty-five years ago primarily to facilitate the interchange of locomotives in case of military concentration and subsequently to enable mass production methods to reduce the capital charges. Brigadier-General Hammond spoke on railway development in the Colonies, and said that British Guiana was the first Colony to build a railway for general purposes; the next Colony to start a railway was Ceylon. The last speaker was Colonel Pollard-Lowsley, who dealt with the work in India of British irrigation engineers. He said that the irrigated area was now 49,451 square miles, which constituted one-eighth of the whole cultivated area of the sub-continent.

## Anglo-Japanese Trade Relations Committee.

As a result of the recent mission to the Far East, the Federation of British Industries has appointed a Committee to maintain contact with the Committee already appointed by the Japan Economic Federation in Tokyo. The aims of the two Committees will be to consider jointly the problems affecting the general industrial relations between Great Britain and Japan, and to offer their good offices to any individual industries which may desire to enter into discussions with a view to a solution of the problems which confront them. The composition of the F.B.I. Committee is as follows:—Lord Barnby, Chairman; Mr. R. W. Allen, chairman and managing director of W. H. Allen, Sons and Co., Ltd.; Sir Arthur Balfour, chairman and managing director of Arthur Balfour and Co., Ltd.; Sir George Beharrell, managing director of the Dunlop Rubber Company, Ltd.; Mr. D. Boyle, director of Andrews Toledo, Ltd.; Lord Cozens-Hardy, chairman of Pilkington Brothers, Ltd.; Mr. J. L. Edmondson, Secretary of the Federation of Calico Printers; Mr. Frank Farrell, President of the Silk Association; Mr. Guy Locock, director of the F.B.I.; Sir Harry McGowan, chairman of I.C.I.; Colonel Morcom, chairman of Belliss and Morcom, Ltd.; Mr. Julian Piggott, director of the British Steel Export Association; Sir Charles Seligman, senior partner of Seligman Brothers, Ltd.; Mr. W. J. U. Woolcock, Chairman of the F.B.I. Overseas Committee.

# The Development of Parsons Industrial Turbo Machinery.

No. II.

(*Continued from page 35, January 11th.*)

THE FIRST TURBINE-DRIVEN CENTRIFUGAL PUMP.

THE first commercial turbine-driven centrifugal pump constructed at the Heaton Works was supplied in the year 1897, to the order of Messrs. Storey Brothers and Co., of Lancaster, who required it for the service of a cotton mill. The design was the direct outcome of the experimental work carried out in 1894 and already alluded to. The normal duty of the pump was to deliver 25,000 gallons of water per hour into a tank against a head of 40ft., about 5 water horse-power being therefore required. For this head the pump ran at 2000 r.p.m. In the event of an alarm of fire in the mill, the pump could be speeded up to 4000 r.p.m., when it would discharge about 40,000 gallons per hour against a head of 160ft., thus developing then about 32 water horse-power. Its maximum capacity on test was the delivery of 53,000 gallons per hour against a head of 165ft. All that was necessary to effect the transformation to fire duty was to adjust the governor to give the increased speed.

The turbine to which the pump was coupled was designed to take steam at 55 lb. gauge pressure per square inch at the stop valve, and to exhaust into a condenser. It was provided with forty pairs of blade rows, varying in height from 0·5in. to 1·375in. A by-pass valve was fitted, enabling the pump to be operated at its maximum capacity even when exhausting to atmosphere. The plant occupied 25 square feet of floor space and weighed about 2 tons complete.

From a catalogue issued by Messrs. C. A. Parsons and Co. in 1897—the same year in which the plant was built for Messrs. Storey Brothers and Co.—it is clear that the pump was of the ordinary single-impeller double-inlet type. In the section of the catalogue relating to the "Steam Turbo Pump," we read: "Until recently the centrifugal pump was generally supposed to be only suitable for low lifts. The fault, however, lay not so much in the pump as in the type of engine employed to drive it, as is shown by the fact that the turbine-driven centrifugal pump is better adapted for high than for low lifts. From 200ft. to 300ft. is easily attained by the ordinary set, and this height may be increased to any desired extent by using the compound centrifugal pump, which may be said to consist of two or more pumps coupled 'in series' on the same spindle."

Turbine-driven pumps were listed in the catalogue in twelve different sizes, ranging from pumps with an inlet pipe diameter of 1·5in. and a delivery of 35 gallons per minute, up to a size of 25in. pipe diameter with a delivery of 10,800 gallons per minute. The head for any size was given as from 50ft. to 300ft. Pumps for higher heads would be quoted for on application. Amongst the features of the turbines supplied with the pumps were mentioned tubular bearings "lubricated from large oil vessels placed immediately above them, which can be replenished by the attendant, and are automatically refilled by an oil pump driven from the engine." The description further states that "each plant is fitted with a mechanical safety governor which will effectually control the speed."

THE FIRST TURBO-COMPRESSOR.

Reference has been made above to a centrifugal air compressor constructed by Sir Charles Parsons in 1887, to be used in connection with an ejector for ventilating the hold of a ship. The design of the compressor, which comprised three 8in. impellers in series, was no doubt due to the analogy of such a machine with a fan on the one hand and a multi-stage centrifugal pump on the other. The activity of the inventor in other directions, particularly in connection with the establishment of the Heaton Works and the development there of turbines of the radial-flow type, necessitated by the loss of control over his original patents, seems to have put an end to further work on air compressors for a number of years. Meanwhile, however, he had noticed that a considerable air pressure was generated by a parallel flow reaction turbine when it was driven round by external power, and it appeared likely therefore that by such a reversal of its functions a turbine might be used advantageously as an air compressor. To investigate the point an extensive series of experiments was carried out in 1897, which seemed to demonstrate that a definitely higher efficiency could be obtained with a machine working on the principle of a reversed reaction steam turbine, than with a compressor of the centrifugal type.

As a consequence of these experiments, designs were prepared for a parallel flow turbo-compressor, capable of compressing 5000 cubic feet of free air per minute to a final pressure of 80 lb. per square inch. This machine was to have consisted of two cylinders working in series, the air being compressed to 25 lb. in the first cylinder and the pressure being increased to 80 lb. by the action of the second cylinder. It was decided to construct the low-pressure cylinder alone, in the first place, leaving the other until later, and in the order book of the Heaton Works for 1899 is a record of "One turbo-compressor, low-pressure cylinder," to be made for stock to the order of C. A. Parsons and Co., Ltd. This cylinder was completed and employed for experimental purposes.

Fig. 13 is the reproduction of a drawing showing the general arrangement of the plant as constructed, with the single compressor cylinder delivering 5000 cubic feet of free air per minute at a pressure of 25 lb.

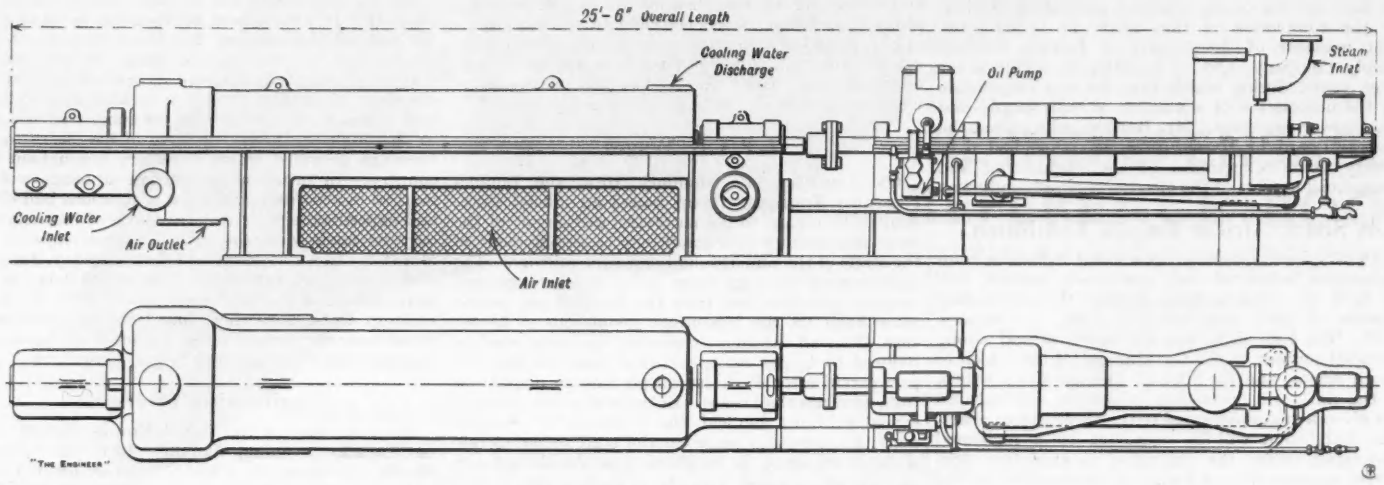



FIG. 13—GENERAL ARRANGEMENT OF TURBO-COMPRESSOR

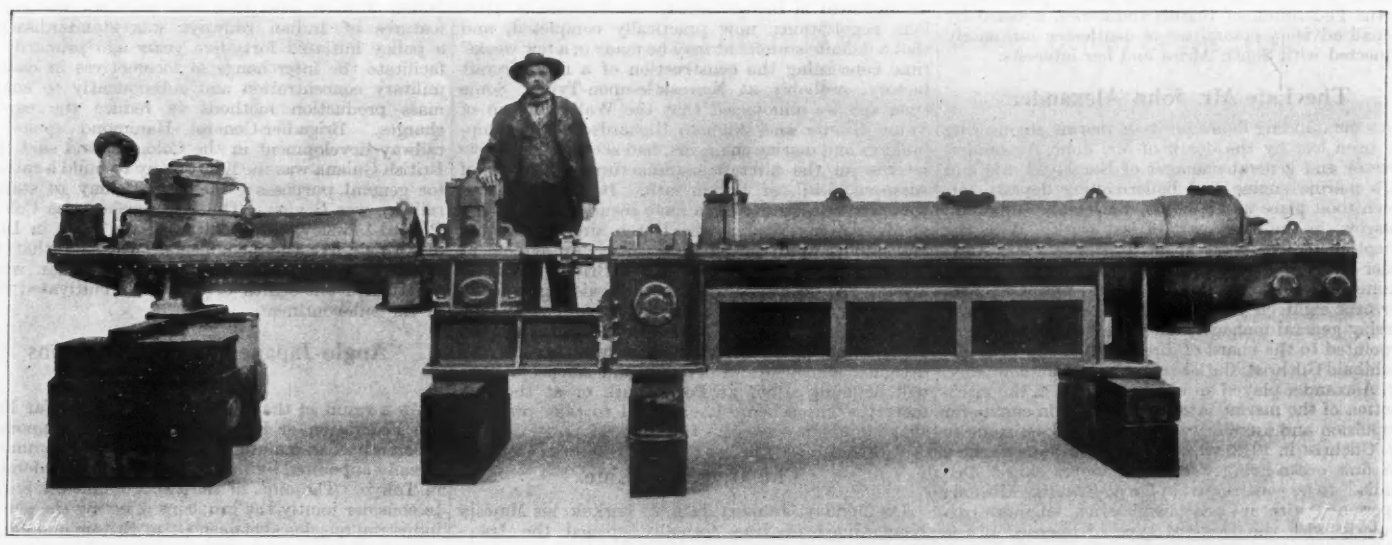


FIG. 14—FIRST TURBO-COMPRESSOR—1900

Fig. 14 shows the complete machine. The turbine was designed to develop from 300 to 400 h.p. at a speed of 4000 r.p.m., and was connected to the compressor by a solid flanged coupling. The compressor, which was very similar in construction to the turbine, contained eighty-one pairs of blade rings. The blades were arranged in four groups of constant height, the heights decreasing successively from 2in. at the inlet end to 1·5in. at the outlet end of the compressor. The rotor body had a uniform diameter of 13in., a length of 8ft. 5in. being occupied by the blading. The whole length of the compressor cylinder was water jacketed, the cooling water flowing in a contrary direction to the air, instead of flowing in the same direction as considerations of uniformity of heat abstraction would seem to require.

As it was, the coolest water entered the cylinder at the hottest end.

The experimental data obtained from this cylinder were sufficient to make it unnecessary to proceed with the construction of the high-pressure cylinder, as originally intended. They were, indeed, complete enough to serve as the basis for the design of several important machines during the next few years.

### TURBINE-DRIVEN FAN FOR THE HULTON COLLIERY.

In the year 1900 a turbine-driven fan was ordered from C. A. Parsons and Co., Ltd., by the Hulton Colliery Company, of Chequerbent, Lancashire, for ventilating the Deep Arley and Two Feet seams. This was the third installation of the kind since the pioneer plant at the Clara Vale Pit in 1896, and as by this time the eight-bladed type of propeller fan had already proved its superiority over the original four-bladed type in the Northumbrian Pit, the improved design was employed for the Hulton Colliery. The duty required of it was the extraction of 80,000 cubic feet of free air per minute under a maximum water gauge pressure of 6in. The fan was of manganese bronze with eight blades, and had a diameter of 42in. over the blade tips. It was designed to be driven directly by a steam turbine at 3500 r.p.m., the turbine taking steam at 150 lb. pressure, not superheated, and exhausting into an ejector condenser under a 26in. vacuum. Under these conditions the makers guaranteed that the steam consumption of the plant should not exceed 40 lb. per air h.p., though better results were anticipated and, in fact, obtained.

Three months after the order had been placed the makers were asked if it would be possible to increase the power of the turbine and to arrange for it to drive a 50-kW dynamo as well as the fan. This was agreed to, the turbine shaft being consequently extended at the high-pressure end and coupled to a two-pole compound-wound D.C. generator of the required capacity, designed to supply current at 440 to 475 volts. The bearings of the turbine, fan, and dynamo were automatically lubricated, the oil being circulated by means of a small reciprocating pump, driven by worm gearing from the turbine shaft. The ejector condenser was supplied with water from a tank 34ft. overhead, which was kept full by a double-acting reciprocating pump, 11in. diameter and 6in. stroke, driven in a similar manner at one-fortieth the speed of the turbine, and delivering 18,000 gallons of water per hour. The pipes, forming part of the forced lubrication system of the whole plant.

The turbine was housed in a small existing brick building, the end wall of which was pierced by a hole 85in. diameter, communicating with the horizontal wooden air drift from the mine shaft. In this hole was fitted the large end of a cast iron cone piece, about 6ft. in length. The small end of the cone, which was 43in. in diameter, was bolted directly to the short cylindrical casing of the fan. To the discharge end of the fan casing was bolted a horizontal bend, terminating in a tapered horizontal steel pipe, leading the air outside the building. When the plant was first put to work it was found that the escaping air emitted an unpleasant musical note, just as had been the case in the earlier installation at the Clara Vale Pit. The difficulty was got over by building a large silencing brick chamber, some 9ft. square by 60ft. long, to receive the air discharged from the pipe.

After the plant had been running day and night for over eight months, with no more attention than an inspection at intervals by the man who fired the boilers, it was decided to subject it to a series of careful tests. Particulars of these tests, which covered a total period of 51·5 hours, are to be found in a paper entitled "On the Erection and a Few Tests of a Turbo-fan and Generator at Hulton Colliery," read by Mr. Alfred J. Tonge before the Manchester Geo-

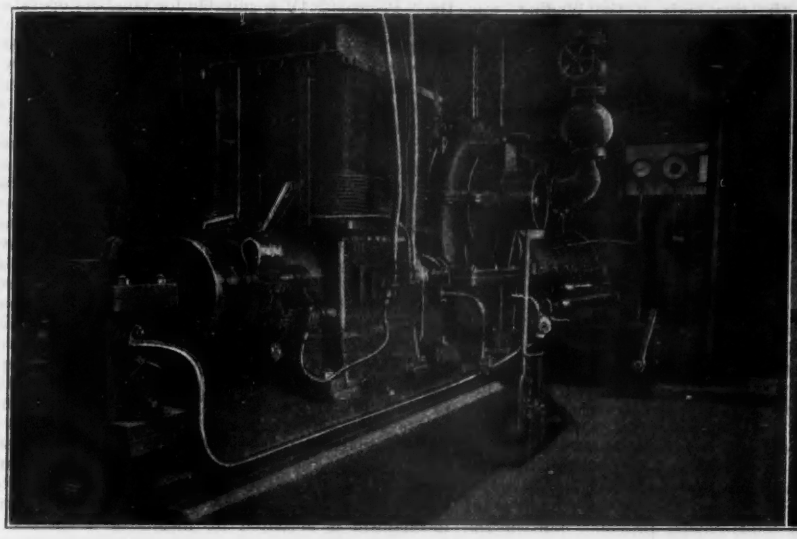


FIG. 15—DYNAMO END OF HULTON COLLIERY PLANT

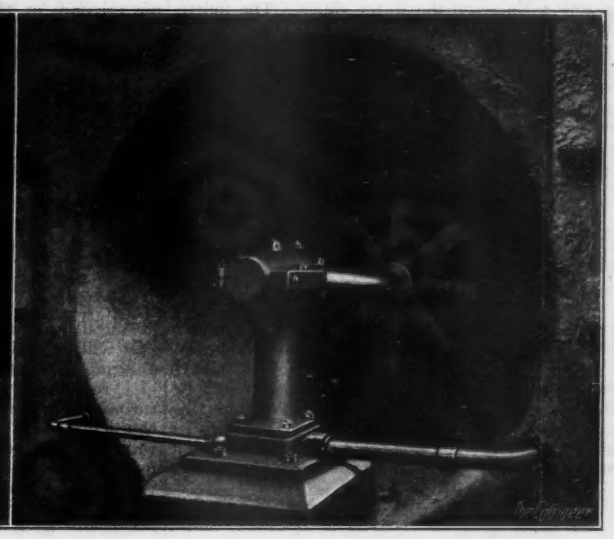


FIG. 16—HULTON COLLIERY FAN

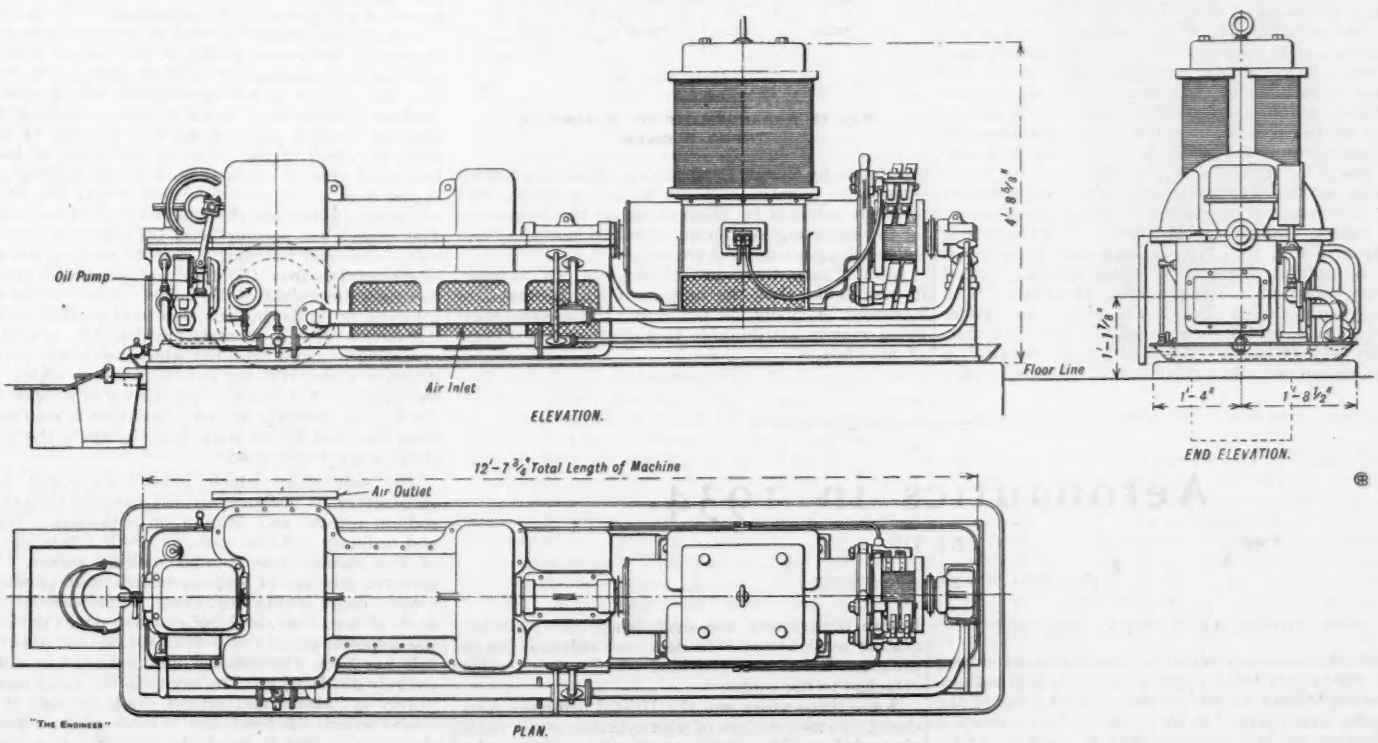



FIG. 17—MOTOR-DRIVEN TURBO-BLOWER—1901

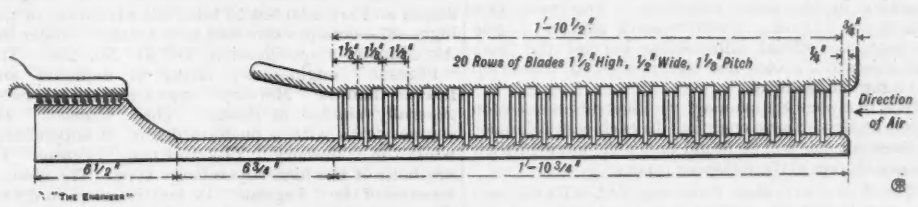



FIG. 18—BLADED PORTION OF TURBO-BLOWER

appearance of the plant, as seen from the dynamo end, is illustrated in Fig. 15, while Fig. 16 gives a view of the fan, taken in the drift and looking in the direction of the air flow. The pipes connected to the base of the pedestal in Fig. 16 are the inlet and outlet oil

logical Society on May 13th, 1902. The principal results obtained are summarised in Table II.

In all the four tests it will be observed that the quantity of air extracted by the fan was considerably greater than that specified. During the first two tests the water-gauge reading was that due to the normal conditions of the mine, but for the third test an obstruction was placed in the main return airway purposely to increase the water gauge. The fourth test was made to determine the effect of cutting out the electrical load and letting the turbine drive the fan alone. The last two columns of Table II show the steam consumption per horse-power-hour of the fan and dynamo respectively. To make this allocation, it was assumed that the fan had an efficiency of 55 per cent., and the dynamo an efficiency of 90 per cent.

TABLE II.—*Tests on Turbine-driven Fan and Dynamo at the Hulton Colliery*, 1902.

| Test No. | Duration of test, hours. | Stop valve, press., lb./in.². | Condenser vacuum, inches. | Speed, r.p.m. | Cu. ft. air per min. | Suction press., inches water. | Air h.p. | Elec. h.p. | Steam per total h.p. hour, lb. | Steam per air h.p. hour, lb. | Steam per elec. h.p. hour, lb. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10·75 | 122 | 19·25 | 3360 | 112,000 | 5·177 | 91·3 | 51·6 | 32·2 | 37·5 | 23·0 |
| 2 | 13·5 | 122 | 19·5 | 3320 | 109,300 | 4·95 | 85·2 | 56·0 | 32·6 | 38·5 | 23·6 |
| 3 | 18·75 | 125 | 19·5 | 3200 | 97,500 | 6·10 | 93·7 | 54·8 | 29·2 | 34·2 | 20·9 |
| 4 | 8·5 | 80 | 20·5 | 3040 | 99,000 | 4·00 | 62·0 | — | 44·5 | 44·5 | — |

### THE FIRST TURBO-BLOWER.

The first turbo-blower supplied for commercial use was a motor-driven unit built to the order of Messrs. Cookson and Sons, of Howdon-on-Tyne, in 1901, for providing the blast for a lead-smelting furnace. Its duty was to deliver 3000 cubic feet of free air per minute at a gauge pressure of 1·75 lb. per square inch. The machine is illustrated in Fig. 17. The blower was driven by a bi-polar continuous-current motor of 50 h.p. at a speed of 4000 r.p.m. The lower half of the blower cylinder, the intermediate pedestal and the bed-plate for the motor were in a single casting, thus ensuring perfect alignment. All bearings were lubricated automatically by a reciprocating oil pump placed at the end of the machine, and driven by worm gearing from the shaft, the drive being similar to that employed for the pumps of turbines of that period. The air entered the blower through screens at the side of the machine, following the practice adopted in the experimental compressor built in 1899. No provision, however, was made in Messrs. Cookson's machine for water cooling, as the very moderate ratio of compression of the air rendered any artificial cooling unnecessary.

A section through the bladed portion of the blower is given in Fig. 18. The working part of the rotor had a uniform diameter of 9·625in., and carried twenty rows of moving blades alternating with twenty rows of fixed blades in the stator. The blades were of brass, held in their grooves by brass caulking-pieces between them. All blades were identical in form, flat on one side and curved on the other. They were all 0·5in. wide, and had a uniform height of 1·875in. Their position relative to each other is illustrated in Fig. 19. The guide blades were fixed with their flat sides parallel to the axis of the machine, while the running blades were set at about 30 deg. to the direction of their motion, and with their flat faces on their upstream sides. The end thrust on the rotor, due to the difference in the air pressure at the two ends of the blading, was balanced by a dummy piston of the labyrinth type.

It will be noticed that, except for the presence of alternate rows of fixed and moving blades, there was little real analogy between the blower and a reaction turbine. The symmetry of arrangement and function characteristic of the blading of the latter is wholly wanting. In the blower the fixed blades were simply for the guidance of the air and the conversion of its velocity into pressure, all the work being done by the moving blades. Each row of the latter acted essentially as a multi-bladed propeller fan, of the type found by Messrs. Parsons to be efficient in dealing with large quantities of air at low pressure, and therefore adopted by them at about the same time for the important ventilating installation at the Clara Vale Colliery already referred to.

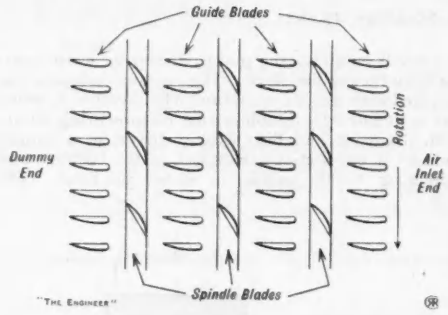



FIG. 19—ARRANGEMENT OF BLADES OF TURBO-BLOWER

After Messrs. Cookson's blower was put to work, it was found that the output of the furnace was increased by about 30 per cent., the improvement being mainly attributable to the greater steadiness of the blast.

*(To be continued.)*

# Aeronautics in 1934.

## No. III.

*(Concluded from page 39, January 11th.)*

### THE BRITISH AERO ENGINE INDUSTRY.

MUCH interesting activity was displayed during the year by British manufacturers of aero engines. In what follows we review the work of some of the leading firms engaged in this branch. Our account is unfortunately less complete than it ought to be for in some cases questions of secrecy or other cogent reasons have prevented certain manufacturers from disclosing the nature of the past year's work. It will be noted in particular that we refer below to only two British firms—the Bristol and the Napier companies—as being engaged on the development of the compression ignition engine. It is known however that at least one other company—Rolls Royce, Ltd.—is active in the same direction. Concerning this company's "Condor" compression ignition engine we have no official information beyond the facts that it is water cooled and that it is rated to develop 500 b.h.p. at sea level.

In a two-page Supplement we illustrate a selection of recent British aero engines. In each case reference to these engines will be found under the name of their manufacturers in the following report.

*The Bristol Aeroplane Company, Ltd.*—Throughout the year the Bristol company's engine department was exceptionally busy. Although resort was made to night-shift working it was found necessary, in order to relieve the congestion, to increase the size of the department by a considerable amount. This extension, now completed, has added 28,000 square feet, representing an increase of 25 per cent., to the machine shop floor space. At the same time a special lead-bronze department was established, the cadmium-plating section was extended, and enlarged hangar accommodation was provided for the flying school attached to the works.

Some three years ago the Bristol company introduced two new designs of nine-cylinder, static radial, air-cooled engines, with overhead poppet valves known as the "Pegasus" and "Mercury." These engines represented developments of the celebrated "Jupiter" engine. By the end of 1934 the company had built and delivered the thousandth engine of the "Pegasus" and "Mercury" series. The latest developments of these engines are the "Mercury" VI-s and the "Pegasus" III and the "Pegasus" IV. These engines are improved versions of the original design and are adapted to take full advantage of the high—87—octane value fuel now available under the Air Ministry's specification, D.T.D. No. 230. The "Pegasus" engines are larger in diameter and heavier than the "Mercury" engine but are otherwise generally similar in design. The "Pegasus" III engine works with a medium degree of supercharge while the "Mercury" VI-s and the "Pegasus" IV are both of the high supercharge type. The characteristics of the "Pegasus" IV may be given in detail. This engine has a normal speed of 2250 r.p.m. and at that speed its output available for take-off at sea level is 675/700 b.h.p. At the same speed at an altitude of 11,500ft. it can develop 640–670 b.h.p. The maximum permissible speed is 2600 r.p.m. and at that speed when flying at 15,000ft. the engine develops its maximum power of 680–710 b.h.p. The "Pegasus." III engine runs at a slightly lower speed. It has a greater power available for take-off at sea level, but its maximum power is developed at a considerably lower altitude namely at 4750ft. The "Mercury" VI-s engine runs slightly faster than the "Pegasus" IV. Its sea level power is about 13 per cent. less but its maximum power is developed at about the same altitude. These differences adapt the engines for different classes of machine. Thus the "Pegasus" IV is suitable for bombers operating at 15,000ft. or upwards. The "Pegasus" III is available for general service or marine aircraft and for certain types of civil machine. The "Mercury" VI-s is particularly adapted for high-performance fighters designed to fly at 200 m.p.h. or more at 15,000ft.

In general the new "Mercury" and "Pegasus" engines show an increase of about 15 per cent. in their power outputs and a substantial reduction in fuel consumption as compared with the earlier series of their respective families. Detailed re-designing and the use of magnesium alloys at suitable points have, however, resulted in the weights being kept within the limits of the previous types. The cylinder barrels are now made of hardened alloy steel and additional fin area has been provided to augment the cooling surface in keeping with the increased power output. The crank shaft is made of a steel of increased fatigue range and is now surface hardened all over. Improvements have also been effected in the carburation system and in the ring cowling which is now of the combined exhaust type. The air screw shafts are made suitable either for standard air screw hubs or for the Hamilton two-position controllable pitch airscrew. In the second case the pitch control mechanism is actuated by means of a valve in a housing on the reduction gear casing and operated by the pilot through an Arens cable. By way of this valve the oil pressure from the engine lubricating system is employed to operate the adjustable pitch mechanism.

Of all the modifications introduced into the new designs, chief general interest will probably be found in the steps taken to keep the exhaust valves reasonably cool under the more trying conditions imposed by the increased engine speeds and brake mean effective pressures. By the use of special heat-resisting steels it was possible to retain a reasonable degree of strength at high temperatures, but in order to obtain still greater powers it became necessary to provide additional cooling to the valves, both to increase their mechanical strength and also to minimise their effect as hot spots which would tend to produce pre-ignition. Work in this connection was directed towards encouraging the transfer of heat from the head of the valve to the cylinder head. Increased area of contact, both at the seating and at the stem was resorted to, but it was also found necessary to increase the conductivity of the valve. This object was accomplished by hollowing out the valve stem and inserting a core of copper, but this scheme suffers from the disadvantage that it greatly increases the weight of the valve. More success was achieved by hollowing the stem and partially filling the cavity with a substance which was molten at operating temperatures, but which had a low vapour pressure under running conditions, and which wet the interior of the stem. As the valve is operated, the fluid is violently agitated, and heat is conducted from the head to the stem, and thence to the valve guide and cylinder head.

The substances which have been found most satisfactory as coolants are the eutectic mixture of sodium nitrate and lithium or potassium nitrate; and ordinary metallic sodium. Both substances are of low specific gravity and melting points. The eutectic mixture of sodium nitrate and potassium nitrate melts at 218 deg. Cent., while sodium melts at 97·5 deg. Cent. and boils at 880 deg. Cent., and has a specific gravity of 0·973. Of late the use of the salt has been discontinued and sodium has almost entirely displaced it. The cavity in the valve may be purely cylindrical and extend along the axis of the stem towards the head, but in cases where a greater degree of cooling is required, the cavity is increased in size at the head to form a partially hollow head. Whichever design is adopted, the result is a valve completely interchangeable with the standard solid one, but which is maintained at a lower temperature, and which is at the same time lighter.

It is in this way possible to obtain an increase in power output by reason of the raising of the detonation point. Some advantage also accrues from the reduction in weight, which might in some cases permit of an increase in engine speed. The reduction in temperature of an exhaust valve filled with sodium, compared with a solid stem valve, varies from 20 deg. Cent. to as much as 100 deg. Cent. The degree of reduction is dependent upon the running conditions and the type of engine in which the valve is fitted. The manufacture of sodium-filled valves presents problems which have required a good deal of development to solve. Sodium-cooled valves are now being used extensively in aero engines in the United States of America, on the Continent, and in this country. The patents covering the use of coolants which are liquid at operating temperatures are held by Mr. S. D. Heron and the Wilcox Rich Corporation of America, while the sole rights in this country are held by the Bristol company.

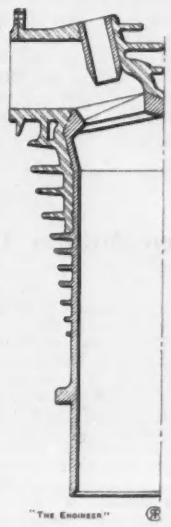
Of the Bristol "Phœnix" static radial air-cooled

compression ignition engine there is little fresh to record. In May 1934 Mr. H. P. Penrose flying a "Westland" machine fitted with a "Phœnix" engine ascended to an altitude of 27,453ft. and thereby established a world's height record with a compression ignition engine.

Side by side with the compression ignition engine the Bristol company as we noted a year ago is paying very close attention to the development of the sleeve valve petrol engine. The company is now concentrating on two designs of this type of engine, the "Aquila" of 15·6 litres cylinder capacity and the "Perseus" of 24·8 litres capacity. Both these designs have now passed their official type tests. They are intended for use in civil machines but developments are in hand in the direction of producing military versions of the engines. The advantages claimed for the sleeve valve aero engine are simplicity, ease of manufacture and maintenance, reduced fuel consumption and ability to run at higher compression ratios with a fuel of given octane number. In addition the clean and symmetrical external form of the sleeve valve engine permits the cowling and baffles to be blended with it in a simple and efficient manner.

Illustrations of the Bristol "Phœnix," "Pegasus," "Mercury," "Aquila," and "Perseus" engines will be found in the Supplement.

*British Salmson Aero Engines, Ltd.*—The engine known as the A.D.9.R. type was developed during the year at the Raynes Park works of the British Salmson company. It is a nine-cylinder static radial engine developing a maximum of 76 b.h.p. at 3300 r.p.m. In its latest form, illustrated in the Supplement, the valve gear on the cylinder heads is completely enclosed in oil-tight boxes and the push rods are contained within telescopic tubes. Constructionally one of its most interesting features is to be found in the design of the cylinders. As indicated in the accompanying sketch the cylinders are of compound construction. They consist of a steel barrel formed with integral cooling fins for about half its working length and a finned aluminium jacket cast round the upper portion and over the head of the steel barrel. Before the aluminium jacket is cast on sheet steel liners for the inlet and exhaust passages are attached to the steel cylinder head by welding. By this construction it is claimed that full advantage is taken of the high heat conductivity of the aluminium without bringing it into direct contact with the hot gases. At the same time the aluminium is relieved of serious stress by the presence of the inner steel structure. The valve guides and sparking plug bosses are completely surrounded by the aluminium jacket, a fact which, it is claimed, ensures thorough cooling of the whole head. The pistons are of aluminium alloy and each is fitted with three cast iron rings. The single-throw crank shaft is coupled to the pistons through one master rod and eight auxiliary rods and drives the airscrew shaft through 2 to 1 reduction gearing. The engine weighs 171 lb. or about 2·3 lb. per b.h.p.




CYLINDER OF SALMSON ENGINE

*Armstrong Siddeley Motors, Ltd.*—Experiments in connection with cylinder and cylinder head design were carried out during the year by Armstrong Siddeley Motors Ltd. of Coventry and resulted in the evolution of an improved form of cylinder unit for the "Genet Major," "Panther," and "Tiger" engines. A cylinder unit of the improved form as produced for the "Panther" engine is illustrated herewith while in the Supplement we also illustrate the "Genet Major" engine as it now appears with the new form of cylinder. The improved design is characterised by an increased closeness of spacing of the external cooling fins and a reduction in the diameter of the sparking plugs with the object of increasing the surface of the combustion chamber. The changes made have resulted in noteworthy improvements in the performances of the engines. For example the new "Genet Major" engine gives 155 h.p. at normal speed as compared with the 140 h.p. developed by the engine with standard cylinders. The "Panther" with the new cylinders gives 560 h.p. at an altitude of 12,000ft. as compared with the same power at 5500ft. given by the same design with the former type of cylinders. The change has also resulted in the "Cheetah" engine developing 290 h.p. at 6000ft., as compared with 270 h.p. at sea level.

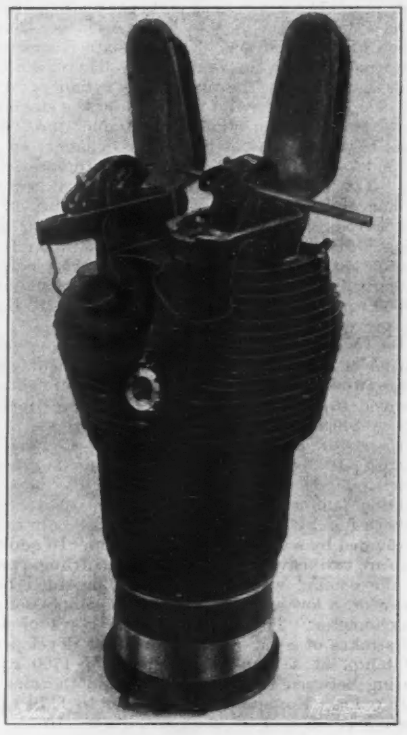
Developments continued to be made in the air-cooling of engines, a subject closely connected with the question of head resistance. The Armstrong-Siddeley engine fairing ring consists of a form of cowling designed to ensure correct cylinder temperatures and at the same time to smooth out the air flow over the engine. The cowling consists of an outer ring encircling the engine and an inner ring shaped and cut away to permit it to be accommodated in the intervals between the cylinders. The two rings constitute an aerofoil section bent as an annulus round the engine, the valve gear and other parts being contained in the hollow interior of the section. Experiments were also made with sodium cooled valves and with "stelliting" the ends of the valve stems in substitution for the insertion of hardened rollers. Farther developments consisted of the adoption of pegged bushes in place of fully floating bushes for the gudgeon pins and the auxiliary connecting-rod wrist pins, the object being to transfer all wear to the comparatively inexpensive bushes and pins. Lead-bronze master rod bearings were tested and cadmium bearings were tried with satisfaction.

A flexible drive to the airscrew shaft was successfully developed. The sun gear of the reduction mechanism instead of being attached rigidly to the casing as previously is now furnished with radial vanes the tips of which fit into slots in the casing. The sun gear, as a consequence, is free to float in a fore-and-aft direction but is prevented from rotating except to the extent permitted by the flexibility of the vanes. A spring-loaded conical friction damping device is provided and is permanently in engagement. As a further refinement directed towards the elimination of vibration, a flexible form of engine mounting ring was produced. This device makes use of two rubber rings which resist the torque reaction of the engine by the shear load on them in their diametral plane.

Means for controlling the "boost" in supercharged engines constitutes a standard fitment but in an emergency it is advantageous to cut out the control, as, for example, when the full throttle output is required near the ground. An arrangement incorporating a system of links was tested which not only gives the pilot the ability to over-ride the boost control but also actuates the mixture control in such a way as to give a full rich mixture during the emergency. In addition to this device the company applied an arrangement for automatically varying the mixture strength according to the air density at any altitude. A flexible coupling between this automatic altitude control and the mixture chamber permits the mixture strength to be varied manually in the event of the failure of the automatic arrangement.

*Pobjoy Airmotors, Ltd.*—The Pobjoy Company's works at Hooton, Wirral, Cheshire, have recently produced two developments of the original "R" type engine namely the "Niagara" and the "Cataract" II engines. The "Niagara" is a seven-cylinder, static, radial, air cooled engine developing a maximum of 90 b.h.p. at 3500 r.p.m. and weighing only 150 lb. Reduction gearing reduces the air screw speed to about 1600 r.p.m. The reduction gearing is double helical and includes a shock-absorber to eliminate "chattering" at low speeds. Alongside the crank shaft gear wheel there is mounted a hollow fly-wheel which is designed not only to steady the drive but to act as a centrifugal filter for the lubricating oil. It is claimed that the noise per horse-power produced by the "Niagara" is less than half that given out by any other engine. This result is attributed to the slow airscrew speed, the smoothness of the exhaust flow and the absence of vibration. It is of interest to record that two weeks after the first "Niagara" engine left the company's test bench in 1934 a Monospar machine fitted with two "Niagara" engines won the King's Cup Air Race at an average speed of 134 m.p.h. The "Cataract" II engine differs from the "Niagara" only in the induction system and in the absence of the cowling which is fitted as an integral part of the "Niagara."

*Wolseley Motors, Ltd.*—The Wolseley Company can claim to be one of the pioneers of aero-engine construction in this country, its first engine of this type having been built in 1909, the year in which Blériot flew the Channel. Subsequently the company produced a number of designs the most notable perhaps being that known as the "Viper." Some time ago it gave up its interest in aero-engines but since Lord Nuffield became governing director the company's activities have undergone development and it has now re-entered the field of aero-engine manufacture. After careful consideration it was decided for the present at all events to concentrate on the static radial air-cooled type of engine. Two patterns are now being built, a seven-cylinder design rated at 145 b.h.p. and a nine-cylinder pattern rated at 185 b.h.p. The two designs are generally similar and we therefore illustrate in the Supplement only the larger engine. Both patterns run at a normal speed of 2200 r.p.m. which may be increased to a permissible limit of 2425 r.p.m. with a gain in the output of over 15 b.h.p. in each case. The seven-cylinder engine drives the air screw direct but in the nine-cylinder type reduction gearing of 0·6295 to 1 ratio is interposed between the crank shaft and the airscrew hub which gives the screw a normal speed of 1385 r.p.m. The crank cases are made of aluminium alloy with a rear end cover, in the case of the seven-cylinder engine, of electron, a magnesium alloy. The crank shaft bearings are carried in stamped steel housings shrunk and bolted into diaphragms in the casing. The cam and tappet gear is enclosed within the front half of the crank casing while the rear half contains the annular induction passage or has the induction ring attached to it. The crank shaft is of the single-throw type and is made of 65-ton nickel-chrome steel. Forged steel balance weights are secured to extensions of the crank cheeks. The connecting-rod assembly consists of a master rod situated in the top cylinder and six, or eight, auxiliary rods attached by wrist pins to webs surrounding the big end of the master rod. Heat treated Y alloy stampings are used for the pistons. The cylinders consist of carbon steel forged barrels and cast aluminium alloy heads screwed on to the barrels. The heads are machined to form dome-shaped combustion chambers giving a compression ratio of 5·35 to 1. They are fitted with single interchangeable inlet and exhaust valves of high nickel-chromium steel, the valve seats being of monel metal in order to withstand the corrosive effect of fuels containing tetra-ethyl-lead. The valve rockers, enclosed in pressed aluminium stream line covers attached to the cylinder heads, are operated through steel tubular push rods from a single four or five-lobed cam driven at one-eighth or one-tenth of the engine speed. In the nine-cylinder engine the reduction gear consists of a seventeen-tooth spur wheel mounted on the crank shaft and engaging with a twenty-seven-tooth internal gear ring attached to a flange at the end of the air screw shaft. The centre lines of these two shafts are not collinear. The induction system as already stated consists of an annular gas chamber at the rear of the crank case. This chamber is fed at two points by an inlet branch



CYLINDER OF SIDDELEY "PANTHER" ENGINE

which is provided with a jacket through which the hot return oil is circulated for the purpose of slightly warming the mixture and preventing the deposition of petrol. From the gas chamber each cylinder is fed by way of a radial aluminium pipe which is attached to the inlet port by means of a cast electron elbow. In the dry condition the engines, together with such items as the hand turning gear, ignition cables, carburetter, air intake pipe, oil pipes, and revolution counter drive weigh 320 lb. and 452 lb. respectively. The nine-cylinder design can be supplied with a direct instead of a geared drive. In this form its weight is reduced to 372 lb., or 2·01 lb. per horse-power.

*D. Napier and Son Ltd.*—Developments of considerable interest are reported from the aero-engine department of D. Napier and Son Ltd. at Acton. Like other British aero engine manufacturers Messrs. Napier are developing the compression-ignition engine for use in aircraft. To this end they have acquired a licence to manufacture the Junkers "Jumo" IV and "Jumo" V C.I. engines and are producing these designs to British standards and sizes and with certain modifications under the names of "Culverin" and "Cutlass" respectively. In addition the company is developing a compression-ignition aero-engine of its own design concerning which no details can be given at present. Two other engine types developed by Messrs. Napier also call for special mention. These engines, the "Dagger" and the "Rapier" are both air-cooled petrol engines but their cylinders, instead of being arranged, as usual, radially round the crank shaft, are disposed in line along it in four banks. By this arrangement the frontal area is reduced to a figure comparable with that of a water-cooled engine.

The Napier-Halford "Dagger," of which we give front and side views in the Supplement, has twenty-four cylinders arranged in four banks of six each. Full details of the design are not at present available but it may be surmised that there are two crank shafts

which are coupled to the airscrew hub through reduction gearing. From the end view the smallness of the frontal area will be gathered. It amounts to about 110 h.p. per square foot. That the engine, in spite of the fact that its cylinders are arranged in four lines, can be satisfactorily air-cooled is proved by its successful performance on the Air Ministry's hundred-hour type test. In addition the same fact has been established by extended trials of the engine in flight on a Hawker "Hart" machine. The engine is fitted with a supercharger capable of giving a normal "boost" of 1½ lb. per square inch and a maximum "boost" of 3 lb. per square inch. From the official type test results we take the following figures concerning its performance:—The fuel used was that known as D.T.D. 230 of 87 octane value containing 4 c.c. of tetra-ethyl-lead per gallon. At sea level the engine develops 610/630 b.h.p. at 3500 r.p.m. but with the maximum "boost" it can develop a taking-off power of 640 b.h.p. at 3000 r.p.m. At an altitude of 10,000ft. and a "boost" of 1½ lb. per square inch its power rises to 665/690 b.h.p. at 3500 r.p.m. while at 12,250ft. using the maximum "boost" of 3 lb. per square inch the power rises to a maximum value of 730/760 b.h.p. at 4000 r.p.m. At the normal crank shaft speed of 3500 r.p.m. the airscrew speed is 1300 r.p.m. The engine has a net dry weight of 1280 lb. or about 1·9 lb. per normal b.h.p. The cruising consumption at 15,000ft. when developing 475 b.h.p. is 0·51 pints per b.h.p. per hour.

The "Rapier" engine may be regarded as a smaller edition of the "Dagger." It has sixteen air-cooled cylinders arranged in four lines. There are two crank shafts one for the two lines of cylinders on the port side and one for the two lines on the starboard side. Master connecting-rods couple the crank shafts to the pistons of the upper cylinders on the port side and the lower cylinders on the starboard side. The remaining pistons are coupled through auxiliary rods attached to lugs on the caps of the master rods. Reduction gearing of 1 to 2·5625 ratio is fitted between the crank shafts and the airscrew shaft. The engine is provided with a supercharger. Running at the normal crank shaft speed of 3500 r.p.m. its output varies from about 285 b.h.p. at sea level to about 305 b.h.p. at 10,000ft.

The Napier-Junkers "Culverin" compression-ignition engine illustrated in the Supplement works on the two-stroke cycle and has six vertical cylinders arranged in line. Each cylinder has two opposed pistons which drive on to two crank shafts. The inlet ports are controlled by the lower piston and the exhaust ports by the upper piston. Fuel is supplied to each cylinder through four nozzles fed by two fuel-injection pumps. The injection pumps in turn are fed with fuel by two gear wheel pumps. Lubrication is provided by a third gear wheel pump. In addition there are two scavenge pumps and a centrifugal pump for the cooling water. Drives are provided for a generator, a low and a high-pressure compressor and a tachometer. The cylinders have bores of 4¾in. and strokes of 8¼in. The horse-power developed is 720 b.h.p. at a crank shaft speed of 1700 r.p.m. Gearing between the crank shafts and the airscrew shaft reduces the speed of the latter to 1179 r.p.m. Starting is effected by compressed air. In the dry condition, without the airscrew hub, the engine weighs about 1785 lb. or 2·48 lb. per b.h.p. It has an overall length of 6ft. 11⅛in., an overall width of 1ft. 11in. and an overall height of 5ft. 7in. The lubricating oil and fuel oil consumptions are stated to be 0·023 lb. and 0·375 lb. per b.h.p. per hour respectively. The engine body is a single casting of "Hiduminium" alloy with steel liners. Modifications of the original German design have been introduced by the substitution of Napier lead-bronze bearings for the crank shaft roller bearings and for the white metal bearings in the connecting-rod big-ends. The addition of an electrical generator and of low and high-pressure compressors represents a further modification of the original design. The first batch of "Culverin" engines is now undergoing test and will be ready for trial in the air early this year. The first batch of "Cutlass" engines, designed to develop 515/535 b.h.p., will, it is expected, be ready for test during this year.

Lead-bronze bearings, it is of interest to note, are used by Messrs. Napier for their own aero-engines and in addition have been supplied to replace white metal bearings in oil-engined trains and tugs, for variable-pitch airscrews and in all classes of road vehicles.

*Cirrus-Hermes Engineering Company, Ltd.*—In the early part of the year the chairmanship of the Cirrus-Hermes Company was taken over by Mr. Robert Blackburn, of the Blackburn Aeroplane and Motor Company Ltd. The whole of the company's organisation was thereupon transferred from Croydon to Brough, East Yorkshire, where a new factory is being built for the manufacture of engines independently of the Blackburn company's aircraft works. The new factory after it had been begun was increased to twice its originally planned size and when finished will be a very well-equipped establishment for the production of light aeroplane engines. It will include seven separate self-contained testing houses, fitted with Heenan and Froude brakes.

The removal interrupted production to a certain extent, but it provided an opportunity for very carefully revising the company's designs of engine. As a result improved versions of the "Hermes" engines are now in production. Two new versions of the "Cirrus" engine are also being developed. No particulars are as yet available concerning one of these new developments, the "Cirrus Major." The other, the "Cirrus Minor" is a light four-cylinder, inverted engine, developing 80 b.h.p. at 2400 r.p.m. or 70 b.h.p. at 2200 r.p.m. The cylinders are arranged in line and are air-cooled. The engine with its controls, magneto, carburetter, propeller boss and bearers weighs complete about 210 lb.

*A.B.C. Motors, Ltd.*—It is of interest to record that as long ago as 1912 a machine fitted with an A.B.C. engine and flown by the late Mr. Hawker established a world's duration record with a flight of 8 h. 23 min. During the war the A.B.C. company produced four types of aero-engine for the Government, the "Gnat," "Mosquito," "Wasp" and "Dragonfly" ranging in power from 40 to 320 h.p. From the end of the war until 1924 the company concentrated on the manufacture of light cars and motor cycles but with the development of the light aeroplane it revived its interest in aero-engines and produced the design known as the "Scorpion." It continues at its works at Walton-on-Thames to produce this interesting little twin-cylinder air-cooled engine of 34–40 b.h.p. The cylinders of just over 4in. diameter and 3·6in. stroke are arranged horizontally on opposite sides of the crank shaft. They are machined from a solid steel bar and are provided with cast iron heads and aluminium pistons. The engine weighs complete 109 lb. An important item of the company's production is a small 4 h.p. twin-cylinder, horizontally opposed, petrol engine designed to operate auxiliaries in an aircraft. In addition to the engine the unit consists of a dynamo, a petrol pump, an oil pump, a water pump and an air compressor. The water, or bilge, pump absorbs the whole power of the engine but the other four auxiliaries may be operated simultaneously if desired. The engine is water cooled and weighs, complete with the five auxiliaries attached to it, 120 lb.

## The Demolition of Waterloo Bridge.

To judge from the care with which the engineers and contractors are tackling the task of demolishing Waterloo Bridge, as much forethought is necessary before such a work can be undertaken as is devoted to the methods by which a new bridge shall be built. When, as is the case with Waterloo Bridge, the structure is already weakened, forethought is doubly necessary. Up to date, as the engineers and contractors express it, much of the demolition work done has been little more than "housebreaking," but when, in a few weeks the actual removal of the arches is begun, the work will become much more interesting.

In the removal of Waterloo Bridge two factors have to be considered. The first is that of safety. It will, of course, be appreciated that as the work proceeds care is very necessary to keep the thrusts of the arches on the piers balanced against one another. In addition, measures must be taken, especially where the structure crosses the Embankment, to ensure that there shall be no danger to pedestrians, and vehicles, below. The other factor to be noticed is that, even as it is, the bridge is an impediment to river traffic and no further restriction can be tolerated. It is this factor that has had the major influence on the choice of the method of demolishing the bridge.

The first work to be carried out consisted of the removal of the balustrade, cornice and frieze, and the digging out of the clay filling beneath the roadway. Above the surface thus cleared, there has been erected a series of temporary steel trusses. There are four of them side by side over each span, except at the centre span, which is already propped from below, and they are supported upon concrete blocks resting on each pier. Upon the upper booms of the central trusses travelling cranes ride. From these trusses centering will be suspended beneath the arches. For this purpose holes have been drilled through the granite arches within which suspension bars attached to the lower booms will hang. The steel centering which is already in course of erection beneath one of the arches is assembled in sections on barges. After being floated into position beneath the arch each section is drawn up into position and attached to the suspension bars. Before removal of the arches is begun this procedure will be repeated at each span, except that one which is already sufficiently supported by timber work. The arrangement is such that the only restriction upon river traffic will be a slight reduction of headroom amounting to about 2ft.

Arch demolition will be begun simultaneously and carried on uniformly at each arch. Each arch will be treated in three longitudinal strips. The stones in the two outer strips which lie under the space between the inner and outer temporary trusses will first be removed. Work will be begun with the lifting of the centre stones, and the remainder will be removed evenly from each side towards the piers. On the completion of this operation there will still remain a narrow "bridge" of arches, the thrusts of which against the piers will still be balanced. Before the removal of the centre stones the weights of these various arches will be transferred to the centering, and the whole load will be carried by the trusses.

The material taken out of the bridge is to be transported away in barges, which, when the arches have gone, will proceed to remove the centering also. There will then remain to be removed the trusses spanning across from pier to pier, which it is intended to dismantle by cantilevering back. There is no need as yet to refer in any detail to the work of demolition of each pier and its foundations. It is to be carried out inside a sheet steel-piled cofferdam, and derrick cranes working from a staging built outside the cofferdams will load the material into barges.

By the courtesy of the engineers, Messrs. Rendel, Palmer and Tritton, we recently had the opportunity to examine the bridge in its present state. As we have already stated, centering is already in course of erection beneath one of the arches. All the holes for the suspension bars appear to have been drilled. Although most of the surface of the bridge has been completely cleared, some of the clay filling has been allowed to remain on the propped arch to which there has been added other weighty material with the object of ensuring that the "line arch" fits approximately the shape of the distorted arch. In connection with the actual structure of the bridge, we were interested to observe that the slabs upon which the clay filling and the roadway rested were supported from the masonry arches by longitudinal walls of brick. The spaces between these brick walls were left void with the object of saving weight.

We look forward to paying a number of visits to the bridge as the work proceeds in the able hands of the contractors, Sir William Arrol and Co., Ltd., in order that we may record the progress made and the difficulties overcome.

## Ten Million Tons of Russian Pig Iron.

As a matter of considerable satisfaction, the Soviet newspapers are recording such great progress in the production of pig iron in 1934 as to place the country in the first place in Europe for the third year in succession. On December 17th, according to the Moscow *Izvestiya*, the total production of pig iron reached 10,000,000 tons, and by the close of the year an additional quantity of 500,000 tons was expected to be made. This year's output will represent an increase of 3·4 million tons over 1933, when the tonnage amounted to 7·1 millions, as compared with 6·2 millions in 1932, 4·9 millions in 1931, and merely 2·3 millions in 1926. The monthly output in the first ten months in 1934 is registered at an average of 862,000 tons, and that in October alone at 957,000 tons, these figures leaving Germany, France, and England far behind.

At the beginning of 1929 the country did not have a single blast-furnace in connection with which all the operations were performed by mechanical means. Now there are stated to be twenty-three furnaces which are fully equipped in this manner, or 48 per cent. of the total number. As a result of the great constructional works which have been carried out in recent years, the geographical location of production has remarkably changed. A second base has been established in the East, in the Kusenetz district, and the Magnitogorsk works was also started in 1934, and produced 1,000,000 tons of pig iron. These two works turned out over 2,000,000 tons, or about one-half of the output in pre-war Russia. Other new iron and steel works have been established in other parts, as, for instance, at Novolipentsky (400,000 tons per annum), Novotulsky and Zaporozsky, while the Azofstal works and the Krivoi Rog works are on the point of completion. Altogether, in the past four years new blast-furnaces of a total output of 8,000,000 tons have been completed.

The introduction of new steel plants and rolling mills, although having made some progress, has by no means kept pace with the growth in the make of pig iron. In this connection the Moscow newspaper states that on the site of the works lie tons of rolling mill machinery, which was purchased two to three years ago, and has not yet been assembled, but will have to be taken in hand in 1935. The production of the steel plants and rolling mills has enabled the country to increase the manufacture of rails from 517,000 tons in 1933 to 800,000 tons in 1934, and to lay new and renew old tracks of a length of 2480 miles; to increase the production of axles and tires, &c.; and to turn out special steels for the motor car works, so as to enable them to construct 70,000 cars in place of 50,000 cars in 1933.

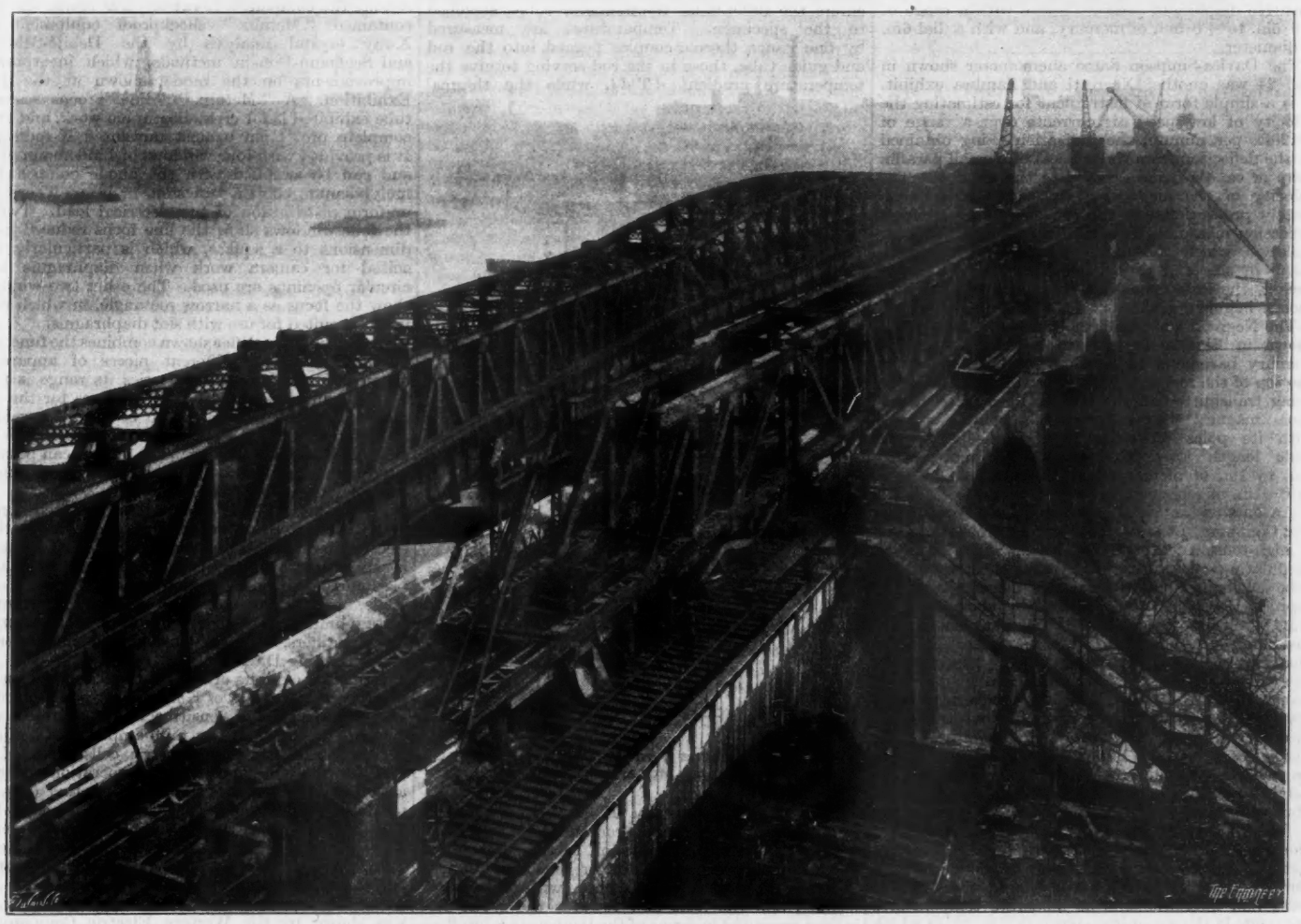
It may reasonably be assumed that practically the whole of the production is being used for the internal economic development, and that this process may be expected to continue for some years yet. It may, however, be noted that offers of Soviet pig iron were made in Belgium, f.o.b. Antwerp, at exceptionally low prices a short time ago, but they did not lead to any business, and may perhaps have been put forward as feelers. But some of the Danish foundries are reported to have recently bought Russian foundry iron or intend to do so on a barter basis for Danish agricultural products, while Japan is known to have purchased a quantity of Russian pig iron for delivery in 1935.

THE Pacific Ocean has been flown across from Honolulu to Oakland, in California, a distance of 2408 miles, in 18 h. 15 min. by Miss A. Earhart.

# THE DEMOLITION OF WATERLOO BRIDGE

MESSRS. RENDEL, PALMER & TRITTON, ENGINEERS; SIR WILLIAM ARROL & CO., LTD., CONTRACTORS

*(For description see opposite page.)*



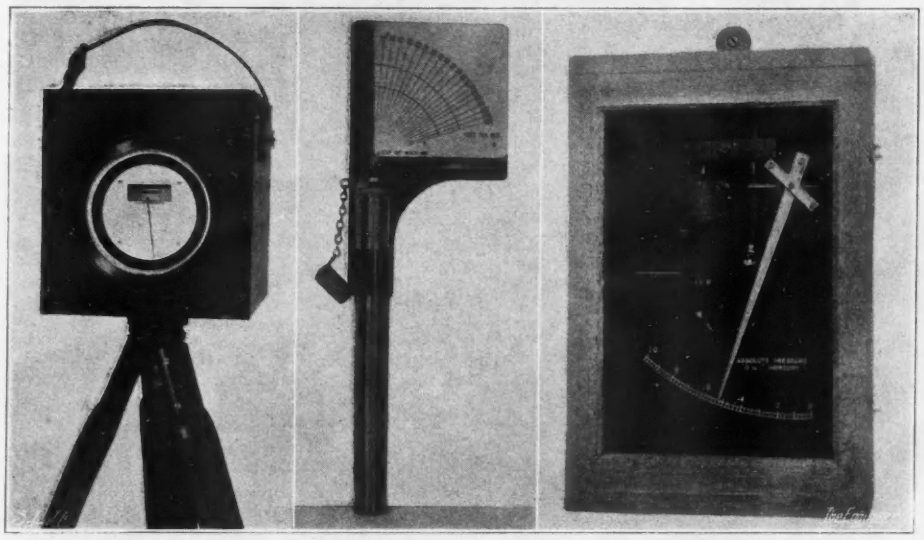
ABOVE:—REMOVAL OF CLAY FILLING OF ROADWAY—AUGUST 31ST, 1934
BELOW:—ERECTION OF STEEL TRUSSES—DECEMBER 31ST, 1934

# The Physical Society's Exhibition.

No. III.

(*Concluded from page 42, January 11th.*)

THE precision surveying or mining statoscope shown in Fig. 23 was one of the exhibits of Negretti and Zambra, of 38, Holborn-viaduct, E.C.1. It enables pressure differences to be ascertained and variations in level to be determined with a higher degree of accuracy than that obtainable with the normal direct-reading aneroid barometer. The instrument case is air-tight, and the pressure in it can be accurately maintained at any "datum" by the adjustment of a diaphragm forming one side and from the indication of a highly sensitive temperature-compensated aneroid movement mounted within it. As it is only subjected to small pressure variations, the movement has no appreciable creep or hysteresis errors. The difference between the fixed internal pressure and that outside the case is indicated by a sensitive diaphragm pressure gauge with a range of −0·5in. to +0·5in. of mercury, and with a dial 6in. in diameter.



FIGS. 23, 24 AND 25—STATOSCOPE, FLAME ANEMOMETER AND ABSOLUTE PRESSURE GAUGE—NEGRETTI

The Davies-Simpson flame anemometer shown in Fig. 24 was another Negretti and Zambra exhibit. It is a simple form of instrument for estimating the velocity of low-speed air currents over a range of 0–120ft. per minute, the indication being obtained by the deflection from the vertical of a small paraffin lamp or candle flame exposed to the air flow. The velocity of the air current measured is approximately proportional to the tangent of the angle of deflection measured on a suitably divided quadrant scale on which the flame deflection is observed. Small in size and capable of being carried in the pocket, the instrument has been used with marked success in gold mines.

The Negretti and Zambra absolute pressure gauge shown in Fig. 25 consists of a short "syphon" mercury barometer in which a steel ball floats on the top of the mercury in the closed limb, its motion being transmitted to the pointer by a small horseshoe magnet mounted on the pointer spindle with its poles on either side of the ball. The scale length is approximately 5in., representing 0in. to 1in. of mercury, and pressures can be read to 0·01in. of mercury.

An outstanding exhibit of the Edison Swan Electric Company, Ltd., of 155, Charing Cross-road, was a high-tension cathode ray tube, with improved modulating characteristics. An application of the tube in connection with variable density television reproductions was demonstrated by showing a 50-line picture obtained from an experimental television signal generator or picture scanner. To show that extremely high writing speeds are possible with the tube, a wave form was recorded on a fluorescent screen from a radio frequency oscillator, giving several mega cycles, and using an improved gas-filled discharge tube as the time sweep generator. Television scans of some hundreds of lines were shown on the high-vacuum cathode ray tube screen to demonstrate lack of distortion and sharpness of focus obtainable with the tube.

Apparatus was shown by Mr. R. W. Powell, of the National Physical Laboratory, for the measurement of the thermal conductivity of metals at high temperatures. The specimens are in the form of rods, and measurements at moderate temperatures are made in the apparatus shown in Fig. 26, in which the rod is mounted vertically, one end being heated electrically, whilst the other end is cooled by a water flow calorimeter. A guard ring surrounding the rod prevents lateral heat transfer, whilst the formation of convection currents is prevented by insulating powder packed in the interspace. Another guard heater is embedded in the refractory base on which the heated end rests and prevents heat flow away from the rod in this direction. When all adjustments have been made, the measured electrical input in the heating coil recessed within the end of the rod should agree with the heat outflow at the other end as derived from measurements of the rise in temperature of the water, and its rate of flow, which is maintained constant by supplying the water from a constant-head tank. Fluctuations of the water temperature are prevented by causing the water to flow through a spiral tube immersed in a thermostatically controlled bath immediately before it enters the differential thermometer tubes attached to the specimen. Temperatures are measured by fine gauge thermo-couples pegged into the rod and guide tube, those in the rod serving to give the temperature gradient $d\,T/d\,l$, while the thermal

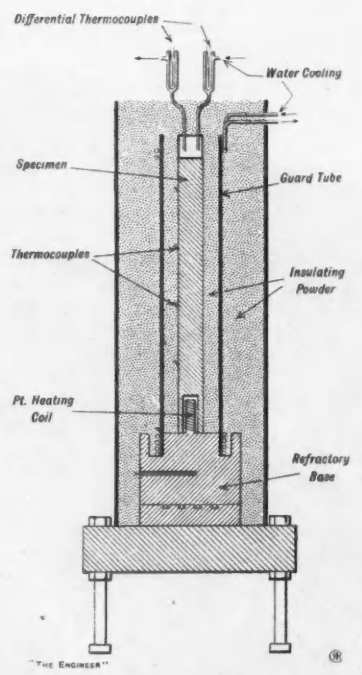



FIG. 26—APPARATUS FOR MEASURING THERMAL CONDUCTIVITY AT MODERATE TEMPERATURES

conductivity is given by $K = H\,A\,d\,T/d\,l$, where H is the heat flowing in the rod and A its area.

To extend the determination to temperatures in the neighbourhood of 800 deg. or 1000 deg. Cent., it becomes necessary to dispense with the water cooling, and the heat flow towards the cooler end is then measured in terms of the temperature gradient in a rod of known conductivity. In the case shown in Fig. 27 the rod is homogeneous and the conductivity at moderate temperatures is first determined in the apparatus described, this value of the conductivity being used later when checking the heat outflow from the end maintained at the higher temperature. As an alternative, a composite rod may be employed with a rod of metal of the same diameter, but of known conductivity attached at the cooler end. For this purpose the thermal conductivity of Armco iron has been accurately determined, and a rod of this metal may be used. To prevent oxidation of the materials at the high temperatures,

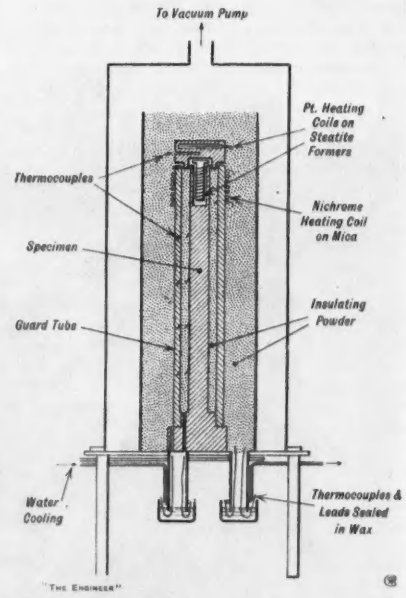



FIG. 27—APPARATUS FOR MEASURING THERMAL CONDUCTIVITY AT HIGH TEMPERATURES

the apparatus is arranged so that it can be continuously evacuated, all thermo-couple wires and heating coil leads being brought out at the base through wax seals. The material under investigation in the apparatus shown at the Exhibition was a rod of Acheson graphite, but measurements have also been made by similar methods to those described on a number of heat-resisting alloys, and it is hoped that the results will shortly be available for publication.

Space will not permit of more than a brief reference to a few of the many exhibits of Philips Industrial Limited, of 145, Charing Cross-road, W.C. 2. Among the company's X-ray apparatus was the self-contained "Metalix" shockproof equipment for X-ray crystal analysis by the Debijé-Scherrer and Seemann-Bohein methods, which incorporates improvements on the model shown at the 1934 Exhibition. A "Metalix" "line" focus research tube exhibited is for crystallographic work, and gives complete protection against unwanted X-radiation. It is provided with four windows of Lindemann glass, and can be supplied with the anode composed of molybdenum, copper, tungsten, or iron. There is a uniform distribution of the electrical load. Two of the four windows show the line focus reduced in its dimensions to a square, which is particularly well suited for camera work when diaphragms with circular openings are used. The other two windows show the focus as a narrow rectangle, in which form it is best suited for use with slot diaphragms.

A new type of rectifier shown combines the functions of three distinctly different pieces of apparatus. When used for charging batteries its range is from 20 to 55 ampères and 10 to 40 ampères for the two models available. It may also be used for welding metal from 18 to 8 S.W.G. and from 24 to 12 S.W.G., and for all kinds of plating. The output can be regulated within fine limits under all conditions by choke control with no loss of efficiency.

Philips hot cathode relay tubes exhibited consist of a gas-filled oxide cathode rectifier with a third electrode, which acts as a control grid. The operation is similar to that of rectifying tubes, in so far as they pass current in one direction only. The third electrode, however, controls the rectified currents within certain limits. The tubes can be applied to battery or other rectifiers, laboratory instruments, and inverters for converting D.C. into A.C.

Industrial exhibits of the Weston Electrical Instrument Company, Ltd., of Kingston By-pass, Surbiton, Surrey, consisted of sensitive relays operated with currents as low as a few milli-ampères, in conjunction with suitable photo-electric cells. One of the relays shown is designed for rapid operation under the action of high-intensity light, and another (Fig. 28) for delayed operation. There was also a relay which gives warning when the smoke in a chimney exceeds a predetermined value. Other exhibits of the company consisted of photographic, wireless, illumination, laboratory, and switchboard instruments.

The high-speed camera and timing clock (Fig. 29) was shown by the Western Electric Company, of Bush House, Aldwych, W.C.2. The clock is driven by a phonic motor from a temperature-controlled tuning fork, and the camera is capable of taking

photographs at the rate of 2000 frames per second. On each individual frame or picture the clock dials are photographed, so that the time intervals for any sequence of operations can be measured. The camera may therefore be used in

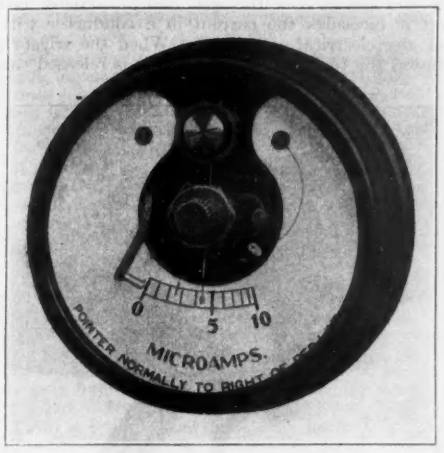



FIG. 28—DELAYED OPERATION RELAY—WESTON

various ways in connection with industrial studies in which it is necessary to obtain slow-motion photographs, together with an accurate measure of the timing of certain operations. By starting the clock when a race begins and by finishing the photograph-

FIG. 29—HIGH-SPEED CAMERA AND TIMING CLOCK—WESTERN ELECTRIC

ing and clock operation simultaneously, the equipment can be used for accurately timing races.

Besides wireless components of various kinds, such as stud switches, &c., Muirhead and Co., Ltd., of Elmers End, Beckenham, Kent, were showing audio and radio frequency attenuators. A circuit diagram of the latter is shown in Fig. 30. It consists of a ladder network terminated in a slide wire, and it may be arranged for mounting on a standard 19in. rack or may be enclosed in a teak box. Means are provided for measuring and adjusting the input to the network and with the specified current the slide wire dial gives a reading in micro-volts, which are multiplied by a factor determined by the position of a stud switch. The current into the network is controlled by a rheostat, and is indicated on a thermo-junction meter. Including the impedance of the thermo junction and that of the current control, the input impedance is 15 ohms, while that of the output circuit is 5 ohms. In addition to the outer screening provided by the panel and copper cover, the whole of the attenuator is enclosed in a second copper box, which is subdivided to give screening between different sections of the instrument and the current control and meter. The screened input connection is brought into the inner compartment through a copper tube and a screened output plug and lead are provided for making connection to a dummy aerial. The range of the instrument is 0–500,000 micro-volts.

Another exhibit of Muirhead and Co., Ltd., was a capacity measuring set, for accurately measuring capacity by substitution in the tuned circuit of a radio-frequency oscillator, with the added advantage that the null indicator is visual. With the aid of the instrument it is possible to measure any capacity up to 1000 micro-microfarad, with a discrimination of 0·03 micro-microfarad. The instrument consists essentially of two radio-frequency oscillators feeding on to a potentiometer across the input to a detector, followed by an amplifying valve working into a step-down transformer which supplies a rectifier pattern meter. The frequency of one oscillator is fixed, while the other is adjusted by means of the standard variable air condenser. For any beat frequency between the two oscillators above 15–20 c.p.s., a full-scale deflection is obtained on the meter. Below this frequency the reading falls steadily to zero.

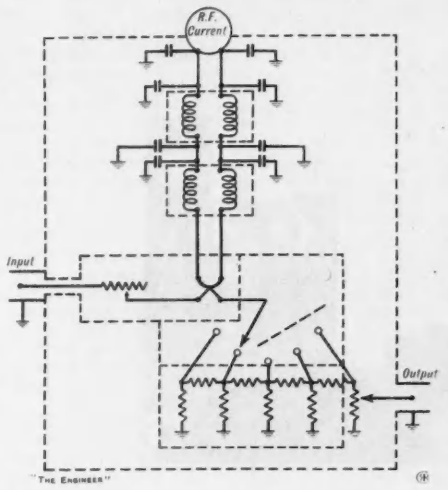



FIG. 30—CIRCUIT DIAGRAM OF ATTENUATOR

The mid-point is chosen as an arbitrary zero, and the standard is adjusted before and after insertion of the unknown, until this reading is obtained.

Apparatus was exhibited by Mr. E. R. Wigan, of the Physics Department of the Woolwich Polytechnic, for the measurement of minute displacements by means of a vibrating system having unstable properties. The apparatus is intended to illustrate two features of a new form of micro-gauge, firstly, the high precision of measurement under the best conditions of use; and secondly, the maintenance of a smaller, though still remarkable, accuracy of repetition under the most severe conditions. Other important points were illustrated, such as the simplicity, durability, and cheapness of the essential elements. To demonstrate the first feature a small calibrating unit, specially designed to avoid the errors of the calibrating screw, was shown in action. The gauge was self-controlled and repeated a given measurement continuously in a 2–5-second cycle. It was demonstrated that the accuracy of repetition of the readings lay in the neighbourhood of $10^{-7}$in. over a period of minutes, without the use of draught shields or thermostatic air temperature control. Shock insulation was provided by small rubber pads under the legs of the demonstration table.

The application of the gauge under more severe conditions was shown in the use of a similar, though lighter, gauge to the recording of extremely small deflections of a Weston moving-coil relay. It was shown that the use of the micro-gauge for this purpose made possible a current magnification, in one step, of 2000 times and more. A current meter, reading milliamps, was caused to duplicate on a larger scale the current of a few micro-amps passing through the relay. This effect was used to obtain on the milliammeter a magnified record of the "unbalance" current from a resistance thermometer bridge (bridge current 30 M.A., resistance of copper thermometer 10 Ω). A change of 1 deg. Cent. of the 10 Ω coil caused a reading of about 1 MA on the meter—a sensitivity many times greater than could be obtained with a more sensitive bridge. The large current magnification was obtained without the addition of any except the simplest apparatus external to the gauge, and the demonstration showed that the gauge recorded the position of the contact arm of the relay to within $10^{-4}$in.

The remarkable sensitivity of this gauge is to a certain extent due to its unstable properties. It consists essentially of a vibrating member, kept oscillating by 50-cycle current drawn from the mains. This member is sufficiently flexible to take up an amplitude of about $200 \times 10^{-6}$in. It is weighted in such a way as to make it potentially unstable. If it grazes any object as it vibrates it tends to burst into a new form of vibration, which results in a sudden change of amplitude. The gauge is provided with means of drawing the vibrating bar towards the object to be gauged, the amount of this movement being read on a current meter reading $40 \times 10^{-6}$in. at full-scale deflection, deflections in the neighbourhood of $10^{-7}$in. being just discernible. The gauge was also provided with a means for indicating the setting-in of the unstable vibration. At the moment the vibrating bar grazed the object to be gauged 50 to 100 M.A. were switched into a robust relay, which caused the bar to be withdrawn from the object and to re-approach it as soon as the unstable oscillation had been suppressed. Thus the gauging operation was made cyclic.

In the first exhibit the vibrating bar was about 4in. by $\frac{5}{8}$in. by $\frac{1}{16}$in. and was oscillated with an amplitude of $200 \times 10^{-6}$in. or so by 5 to 10 M.A. passing through the windings of a magnet system similar to that of a telephone receiver. The bar carried a small but robust jar-sensitive contact which operated the control relay directly. Except for the external supply and control circuits, the gauge consisted simply of the vibrating bar, its supports, and the driving windings. A lighter form of gauge was used for the second exhibit. The consistent operation of this gauge under the very severe conditions operating at the Exhibition is attributed to its small size and mass, its rigidity, and the complete absence of rubbing surfaces or pivots.

This gauge is the subject of British Patent 18,812/34 and its many commercial applications are now under consideration. A simple Griffin and Tatlock thermostat regulator incorporating the micro-gauge was exhibited. It is sensitive to a temperature change of considerably less than $^1/_{100}$ deg. Cent. and under proper conditions should therefore control a fluid medium to within $\pm^1/_{100}$ deg. Cent.

A projected scale indicator—Fig. 31—for use with any of the electrical heat sensitive devices was one of the exhibits of the Foster Instrument Company, of Letchworth. The instrument consists

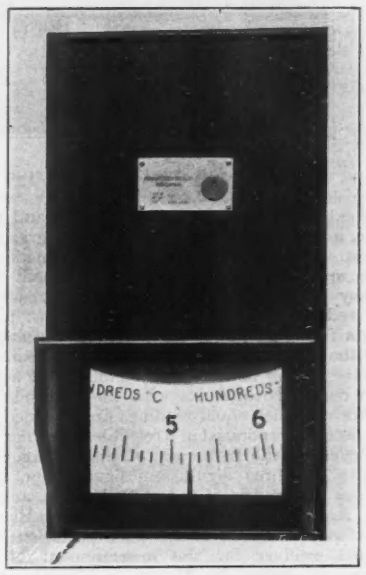



FIG. 31—PROJECTED SCALE INDICATOR—FOSTER

of a highly sensitive moving coil galvanometer having a minute scale mounted on and turning with the coil. By means of an optical and illuminating system a greatly enlarged image of a small section of the temperature scale is projected on to a screen in the front of the instrument, and in effect the scale is seen to move across the screen in relation to a fixed pointer. The complete apparatus is self-contained in a metal case for wall mounting and is supplied from the lighting mains. The magnification is such that temperature readings can be taken with fine discrimination with practically any lighting conditions and from considerable distances.

The Foster "Flexipush" automatic temperature

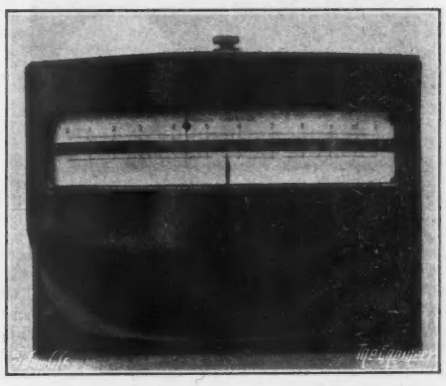


FIG. 32—TEMPERATURE CONTROLLER—FOSTER

controller, shown in Fig. 32, is designed for use in conjunction with oil, gas, or electrically heated industrial furnaces. A motor-driven depression mechanism is used in the normal manner to depress periodically the temperature indicating pointer, and these motions serve to operate a flexible wire moving freely in an incompressible outer sleeving, instead of complicated mechanical selecting and locking devices, or delicate contacts, or electromagnetic relays as previously used.

According to the position of the temperature pointer, the "Bowden" transmissions tilt a large sealed mercury switch into one of two positions, and this switch serves to control either motor-operated fuel valves or contactor gear according to the heating medium used.

One of the exhibits of the British Electrical and Allied Industries Research Association was an earth tester adapted to measure the resistance of sub-station earth electrodes which have very low values.

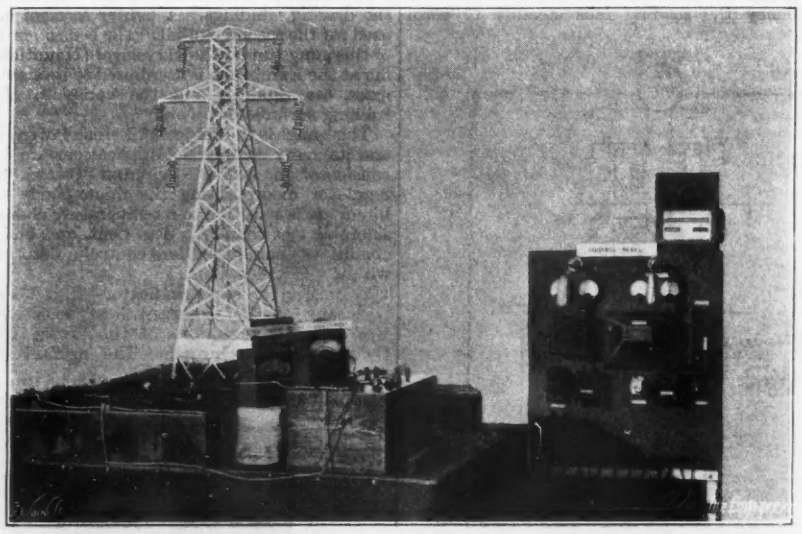


FIG. 33—EARTH TESTING APPARATUS—RESEARCH ASSOCIATION

It was exhibited by Messrs. H. G. Taylor and H. W. Baxter, in conjunction with a model of a grid tower, as shown in Fig. 33, on which tests were made. The results are independent of the resistance of the auxiliary current or potential electrodes, and are unaffected by stray D.C. currents or A.C. leakage currents from the power system. The principle on which the instrument is based is the comparison of the voltage drop in the earth against that across a known resistance in series with the electrode; the indicator on which equal readings are obtained being a voltmeter incorporated in a selective amplifier tuned to 30 cycles—the frequency of the testing circuit. Accurate to three significant figures, the instrument has five ranges of 0·1, 1·0, 10, 100, and 1000 ohms. Among other exhibits of the British Electrical and Allied Industries Research Association was a standard receiver for the measurement of radio interference, shown by Messrs. L. H. Daniel, W. Nethercot and Dr. S. Whitehead.

The Cambridge Instrument Company's exhibits were mainly electrical, and many of them were shown for the first time. There were galvanometers and accessories, indicating instruments for A.C. quantities, resistance measurement, and capacity measurements, A.C. and D.C. bridges, and oscillographs.

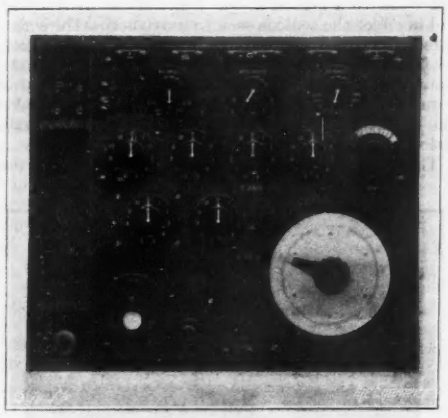


FIG. 34—UNIVERSAL BRIDGE—CAMBRIDGE

Space does not permit of the consideration of all the new or even the more important of these instruments in detail, but attention may be drawn to the Cambridge universal bridge (Fig. 34), which measures D.C. resistance from $10^{-4}$ to $1{\cdot}11 \times 10^{6}$ ohms, self-inductance from 0 to 100 henries, mutual inductance from $\pm 11{,}100$ microhenries, frequency from 400 to 10,000 cycles, and capacitance from 0 to 11·1 microfarads. The effective resistance of inductances and the power factor of condensers are also given to a fair degree of accuracy. The bridge is direct reading for all quantities except frequency, for which a table is provided. It is simple to use and of sufficient accuracy for all classes of routine measurement. A sensitive pointer galvanometer is used for D.C. work, while a sensitive single ear-piece telephone is provided to serve as an A.C. detector. The D.C. supply is taken from an 8-volt self-contained battery, which also feeds a 900-cycle screened microphone hummer for the A.C. source.

Some of the Igranic Company's exhibits were described in our issue of November 23rd in connection with the recent Machine Tool Exhibition and need not be considered here, but a piece of apparatus that was not dealt with on that occasion and which was also shown at the Physical Society's Exhibition was the chain-operated circuit breaker—Fig. 35. A few links of standard roller chain which become rigidly locked together when the breaker is closed form the connection between the manually operated lever and contact lever. Compared with the conventional

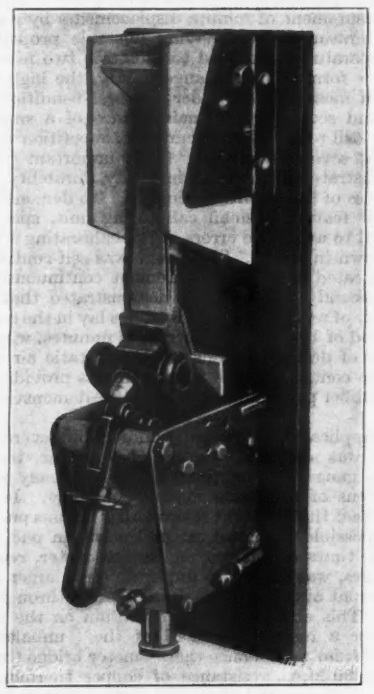


FIG. 35—CIRCUIT BREAKER—IGRANIC

toggle linkage, the link is extremely simple; it is free from wear and requires no adjustment.

The Westinghouse metal rectifier now in use in many branches of electrical engineering was again in evidence. New applications of these rectifiers are constantly being found, both on the heavy and light sides of the electrical industry, in which they serve for converting A.C. to D.C. in the simplest manner. Apart from the metal rectifiers exhibited by the Westinghouse Brake and Saxby Signal Company, Ltd., of 82, York-road, King's Cross, many of them were to be found associated with electrical instruments shown by other firms. New instrument rectifiers with improved characteristics enable them to be used in conjunction with such special instruments as power output meters for audio-frequency amplifiers. Among the Westinghouse exhibits was a rectifier set giving a nearly constant D.C. output voltage over a wide range of load, a new rectifier set designed for laboratory work in schools and colleges, and a pair of output meters, one reading peak and the other the mean power output of a radio receiver. In the research section of the exhibition there was a 50-kW Westinghouse metal rectifier operating a high-voltage cathode ray oscillograph.

Crompton Parkinson, Ltd., of Chelmsford, were showing, as usual, a wide range of electrical instruments, including the small "tong test" ammeter—Fig. 36—which will take readings down to 4 ampères in a straight-through conductor. Like the firm's larger instruments of this kind, the new model is of the split electromagnetic type and it measures the current in a conductor without any electrical connection. When the trigger is pressed the tongs open and when it is released they

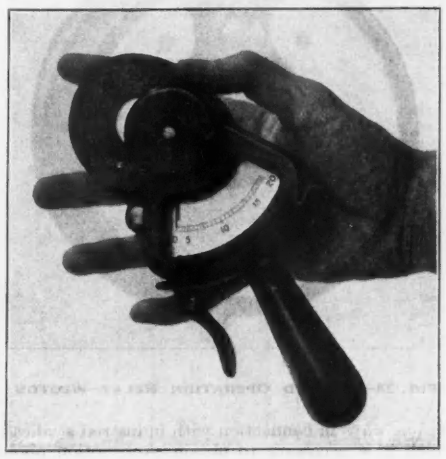


FIG. 36—SMALL "TONG TEST" AMMETER—CROMPTON PARKINSON

embrace the conductor in which the current is flowing. The instrument has a Mumetal electromagnet and moving element and is claimed to give first-grade accuracy on both A.C. and D.C. circuits. Instruments are made with three ranges, viz., 0–20, 0–30, and 0–40 ampères, the first clear reading being one-fifth of the maximum in each case. The instrument is small and light enough to be carried in the pocket and has been designed to meet the requirements of maintenance men.

## INTERNATIONAL CONGRESS ON LARGE DAMS.

AT the end of June, 1933, there was opened in Scandinavia the first International Congress on Large Dams. It was organised by the Commission on Large Dams which is associated with the World Power Conference. Naturally, we could not deal completely with the work of the Congress, but in our issues of July 21st and 28th of 1933 we gave some account of the proceedings. Last year the full Transactions were published in five volumes by the International Commission, and are obtainable from Percy Lund, Humphries and Co., Ltd., 12, Bedford-square, W.C.1, at the following prices:—Vol. I, £1; Vol. II, £2; Vol. III, £1 5s.; Vol. IV, £1 11s. 6d.; Vol. V, 7s. 6d.; or in a complete set for £4. With the exception of the last volume, which deals with various communications, each of the others is devoted to a single principal question. Thus Vol. I is given up to the papers on "The Deterioration by Ageing in the Concrete of Gravity Dams"; Vol. II to "The Influence of Internal Temperature on the Deformation of Gravity Dams"; Vol. III, "Researches to Ascertain the Suitability of Material for Earth Dams"; and Vol. IV, "The Physical Laws Controlling the Infiltration of Water Through Earth Dams and the Underlying Ground." The arrangement of the volumes is the same in all. First, the papers are given in the original language, French, German, or English, with a summary in the other two. Then follow notes upon general aspects of the subject, with suggestions for discussion, and then reports of the meetings. The volumes are well printed and illustrated and, like all World Power Conference publications, contain a wealth of material for reference. In this connection we cannot but regret that each volume is not provided with a complete index. The Tables of Contents given are of very little value.

## BOOKS OF REFERENCE.

*The "Practical Engineer" Electrical Pocket Book, 1935, and the "Practical Engineer" Mechanical Pocket Book, 1935.* London: Humphrey Milford, Oxford University Press. Price 2s. 6d. net each book.—These two handy little books have been again issued in their well-known form, certain sections having been revised and brought up to date. In the former the section on lifts has been rewritten, and that on switchgear amplified. In the "Mechanical Pocket Book" alterations and additions have been made in the sections dealing with materials, friction, and power transmission, and steam generation.

*The South and East African Year Book and Guide, 1935.* Edited by A. Samler Brown and G. Gordon Brown. London: Sampson Low, Marston and Co., Ltd. Price 2s. 6d. net.—The fact that this book has reached its forty-first issue shows its unquestionable value as a reference work for all who have dealings with South and East Africa, either from the business man's or traveller's point of view. The publishers state that over 3500 amendments have been made to the matter and figures given in the previous issue, so the information contained in its more than 1000 pages of text can be relied upon as quite up to date.

## Rail and Road.

ACCORDING to the programme of the London Passenger Transport Board, there will be 137 escalators working on the Underground Railways by the spring of the present year. The fastest escalators run 160ft. a minute, although they are capable of a speed of 180ft.

THE published traffic receipts for the four grouped companies indicate that for the full year of 1934 there were increases as follows:—L.M.S., £2,081,000, or 3·61 per cent.; L.N.E., £2,007,000, or 4·75 per cent.; G.W., £547,000, or 2·25 per cent.; and Southern, £400,000, or 2·04 per cent.

A STATEMENT having appeared in the daily Press that the Great Western Railway Company was closing the Severn Tunnel on Sundays for the next three months "for inspection purposes," it is officially announced that such is not the case; the reason for the diversion of traffic *viâ* Gloucester is to allow for the usual annual relaying.

WE regret to record the death last week of Mr. Tom R. Johnson, who was the Chief Commissioner of Railways for New South Wales, from which position he retired in 1918. To the old generation of engineers and of railwaymen, Mr. Johnson will be remembered as the son of Mr. Richard Johnson, for many years the Chief Engineer of the Great Northern Railway, and as the assistant to Mr. Alexander Ross, who succeeded Mr. Richard Johnson.

TWICE within a recent week there has been a broken rail in Balcombe Tunnel, on the London-Brighton section of the Southern Railway. Since this section of line is equipped with automatic signalling, the rails are continuously bonded for track circuit purposes. A broken rail, as a rule, will interrupt the current that flows through the rails from the track battery at the outgoing end of the section to the signal at the ingoing end, so that the signal is put to, or held at, "danger" and the rail fracture automatically revealed.

FROM a return just issued by the Ministry of Transport covering the year ended December 31st, 1933, for companies, and March 31st, 1934, for local authorities, it appears that the tramway route mileage at the end of the period covered by the return was 94 miles less than at the end of the preceding period. This decrease is largely attributable to the abandonment of tramways in favour of motor omnibuses or trolley vehicles, and a reduction of £5,133,736 in capital expenditure is due mainly to writing off the cost of superseded tramway capital assets.

THE reference in "Harbours and Waterways in 1934," on page 22 of our issue of January 4th, to the L.M.S. £85,000 scheme for the reconstruction of the equipment at Fleetwood, reminds us that the line between Preston, Blackpool and Fleetwood was jointly owned by the London and North-Western and Lancashire and Yorkshire. The latter was the predominant partner, having two-thirds of the interest. Fleetwood was its peculiar care, and the Fleetwood–Belfast steamers give the most popular cross-channel service for the North of Ireland. One of the first grain elevators in this country was fixed at Fleetwood in the middle 'eighties. The railway was opened on July 16th, 1840.

IT may be recorded of the late Sir Alfred Ewing in this column that he was the technical member of the Departmental Committee on Accidents to Railway Servants in 1914. When Parliament was opened that year the Labour Party sought to insert in the Reply to the King's Speech a reference to accidents to railway servants, and, in particular, the working of the Act of 1900. The amendment was withdrawn on Mr. Sydney Buxton promising to inquire into the matter. The Committee commenced its inquiry on June 9th, and sat until July 24th, when it adjourned for the summer vacation. The outbreak of war prevented its resumption and the subject was dropped. It served a useful purpose though, in that it was shown that both the Board of Trade and the railway companies fully complied with the Act; any deficiences there might be were in conditions not provided for in the Act.

IN a Journal note of November 2nd we referred to the agreement of the London County Council to the proposal of the Ministry of Transport that the question of the possible construction of a road bridge at Charing Cross should be referred to the London and Home Counties Traffic Advisory Committee for full discussion and a report. On Tuesday, January 8th, the Minister of Transport, Mr. Hore-Belisha, announced that a sub-committee had been appointed for the purpose of this investigation, the members of which are as follows:—Sir Henry Jackson (Chairman), Mr. Harold E. Clay, Mr. F. Bertram Galer, Mr. Charles Latham, Mr. A. Matheson, Sir John R. Pakeman, Alderman Ben Smith, and Mr. H. Alker Tripp. Among other things, the Committee will consider the possible development of areas covered by obsolete and unprofitable buildings in the locality of the proposed bridge.

THE Boroughbridge branch of the London and North-Eastern runs from the York-Northallerton main line at Pilmoor to Knaresborough and provides a local passenger train service to and from Harrogate; from Pilmoor, running in an easterly direction, is another branch line to Malton, but no longer is there a direct service over that road from Pilmoor. With the sanction of the Ministry of Transport a very interesting experiment is to be made on the Boroughbridge branch. The usual "running" signals are to be dispensed with; the distant is to be replaced by a "location" board, which will be picked up by a powerful headlight on the engine and so warn the driver that he is approaching a station—or it may be a public road level crossing. At the station will be a larger board, having normally three vertical red lights. If the train may enter the station one of the platform staff will raise a flap, which will hide the red lights and exhibit a green "clear" signal. The branch, 12 miles in length, with three intermediate stations, will continue to be worked on the staff-and-ticket system and the points in the main line will be held by a lock, the key of which is the train staff. No main line movement can therefore be made unless the train staff is there and the points must again be normal before the train staff can be withdrawn from the lock for the train to proceed on its journey. This method of controlling points on single lines is not a new feature; it is at least sixty years old.

## Miscellanea.

A SEA defence scheme, which will cost £80,000, is being undertaken by the Romney Marsh Catchment Board.

WORK has been started on the new station of the B.B.C. at Bunghead, which is to be built at a cost of £100,000.

THE world's fastest motor car, "Blue Bird," has been re-designed and Sir Malcolm Campbell hopes to break his own speed record of 272 m.p.h. He expects that the rebuilt car will be some 30 m.p.h. faster.

IT is proposed to expend £418,000 on new boilers for the Willesden and Battersea power stations of the London Power Company. Two boilers at Willesden station will each have a capacity of 90,000 lb. per hour and three at Battersea 375,000 lb. each.

A SYSTEM for the use of solid carbon dioxide in fire-fighting appliances has been developed by Mr. G. E. Heyl, says the *Chemical Trade Journal*. The cylinders can be refilled by the users, solid blocks of carbon dioxide (mixed with a small percentage of methyl bromide) being inserted through a cap in the end.

IT is reported that the Soviet Government has decided to produce 112,200,000 tons of coal this year, of which the Donetz mines are to deliver 68,000,000 tons, the Kuznetsky Mines 14,000,000 tons, and those in the Moscow region 7,000,000 tons. Particular attention will be given to the Central Asiatic coalfields this year.

WORK has been started on the construction of the new plant at Seaham Harbour for the production of oil from coal. It is stated that the new works will cost some £225,000 and use about 500 tons of coal a day. When in full operation the plant's estimated output will be 4,500,000 gallons of motor spirit and 120,000 tons of smokeless fuel a year.

A VERY novel electric motor has been patented in France by the Société d'Optique et Précision de Levallois. The rotor is a cylinder of piezometric quartz placed in a three-phase rotating field. Under the influence of the field the quartz is set into vibration and its deformation gives rise to surface charges which, under the rotating field, cause it to revolve.

IT has been announced that the L.M.S. Railway Company has decided to expend about £85,000 upon an electrification scheme at its Fleetwood docks and station. Electricity is to be used instead of the existing hydraulic plant for operating cranes and capstans and luggage lifts at the station and twenty-eight machines in the engineering shops are to be driven electrically, while electrically driven conveyor belts will be used for coaling trawlers.

WITH the object of bringing the principal cities along the coast of China closer, the Chinese Maritime Customs has decided to build radio stations at Shanghai, Chefoo, Amoy, Swatow, Kowloon, and Kuingchow, at an estimated total cost of 200,000 dollars. The China Radio Service Corporation has been given sole charge of the installation at the above six stations. It is the first time in China, it is stated, that radio installation on such a big scale has been undertaken by a Chinese firm with purely Chinese capital.

IF a rod of iron, steel, or nickel is placed axially in a solenoid which is excited by direct current, and if the rod is caused to vibrate longitudinally with its natural frequency, the changes of mechanical stress will produce corresponding changes of flux in the rod, so that an e.m.f. of the same frequency will be induced in a search coil which embraces the magnetised part of the rod. The frequency of this e.m.f. is measured by means of oscillograms, from which the value of Young's modulus is easily found. This method is described and discussed in a paper presented by Dr. T. F. Wall to the Institution of Electrical Engineers.

THE Official Returns rendered to the Electricity Commissioners show that 1557 million units of electricity were generated by authorised undertakers in Great Britain during the month of December, 1934, as compared with the revised figure of 1536 million units in the corresponding month of 1933, representing an increase of 21 million units, or 1·4 per cent. During the year ending December 31st, 1934, the total amount of electricity generated by authorised undertakers was 15,459 million units, as compared with the revised figure of 13,562 million units for the corresponding period of 1933, representing an increase of 1897 million units, or 14 per cent.

IN a paper on "The Chemical Engineer and his Training for Industry," read before a meeting of the Manchester Section of the Society of Chemical Industry on January 4th, Dr. A. J. V. Underwood said: "Even more important than the mere acquisition of knowledge is the training of the reasoning powers, the faculty of thinking clearly and the spirit of inquiry. Too frequently these suffer as a result of the cramming process, and knowledge is acquired at the expense of the ability to apply knowledge usefully. But when all is said and done, laying down a course of instruction and putting students through it is not a mechanical process of manufacture; and an enormous amount depends on the personality of the teacher who, in addition to the requisite human qualities, must be a man of wide industrial experience."

WHILE investigating the magnetic properties of metallic neodymium containing about 7 per cent. of iron, Messrs. V. Drozzina and R. Janus, of the Physico Technical Institute of the Ural, found, according to a letter in *Nature*, that this material is strongly ferro-magnetic. Its specific magnetisation (near saturation) in a field of 20,000 Oersted is about 13 at room temperature. "It is rather difficult to assert at present," say the discoverers, "whether we are dealing with a homogeneous alloy of iron and neodymium, or whether the finely dispersed iron is imbedded among the neodymium grains. The value of the specific magnetisation seems to correspond to about 7 per cent. of free iron. Yet the material investigated by us shows an extraordinarily great coercitive force, reaching 4300 Oersted with a remanent magnetisation equal to 70 per cent. of the maximal temporary value. This enormous coercitive force, so far as we know, has never been observed either in pure iron or in any of its alloys. Thus we may conclude that these remarkable magnetic properties are due to a hitherto unknown iron alloy."

## Air and Water.

WORK is to begin at once on a new municipal airport at Perth.

A FORMATION flight of four Short Singapore III flying boats has left Pembroke Dock for Singapore, where they are to be stationed.

THE Commander of the "Berengaria," Captain Sir Edgar Britten, R.N.R., has been appointed first Commodore of the Cunard White Star fleet.

TWO new French destroyers, the "Volta" and the "Mogador," have been laid down at Nantes. They will each have a displacement of 2930 tons and engines of 90,000 h.p.

TO relieve the pressure on Croydon aerodrome control tower, two new radio telephony stations, equipped with direction-finding apparatus, are being fitted up at Lympne and Pulham.

THE Spanish Cabinet has authorised the drafting of Bills providing for the building of twelve gunboats and modernising two battleships for the Spanish Navy, says *The Times* Madrid correspondent.

ACCORDING to reports from Holland, Mr. Anthony Fokker, the Dutch aircraft manufacturer, has announced his intention to build "Fokker" and "Douglas" aeroplanes in this country in association with Airspeed, Ltd.

THE Drafting Committee of the International Shipping Conference met on January 15th; and considered the principles and basis of a scheme for recommendation to the preliminary meeting. Sub-committees were appointed to go into certain technical questions.

IT has been stated that the disaster to the Dutch air liner, which crashed in the desert near Rutbah, was not caused by lightning. According to Mr. Plesman, the aeroplane, on landing, overturned after travelling 100 yards at a speed of 150 miles an hour.

A SERIES of difficult tests was recently made by a C.30 direct-control-type Autogiro flown by Mr. R. A. C. Brie, who repeatedly alighted and flew off from a 33ft.-wide platform rigged on the Italian cruiser "Fiume." The tests took place with the vessel steaming at 24 knots.

IN the course of a paper before the Netherlands Royal Institute, Mr. J. Hopman said that a syndicate had been formed in Holland to prepare plans for a regular airship service between Holland and India. The leading Dutch liner and air line companies have become members of the syndicate.

AMONGST suggestions for developing air transport in Great Britain, made at the first conference of the Air Transport Section of the Society of British Aircraft Constructors, Major R. H. Thornton proposed the erection of radio beacons along air routes and the setting up of a national airways board.

THE first of a fleet of coastal motor torpedo boats built by John I. Thornycroft and Co., Ltd., for the Siamese Government has run its trials on the Thames. The boats are 55ft. long, having a speed of 40 knots, and carrying two torpedo tubes, a Lewis gun, depth charges, and wireless equipment.

ACCORDING to the Berlin correspondent of the *Financial Times*, the German civil air company, Eurasia, is negotiating with the German Lufthansa on the question of opening up a permanent direct air service between Berlin and Shanghai. This service would follow the route Canton, Anam, British India, and Greece, and would establish connections at Rangoon with the three air services already connecting Europe with the Far East. The duration of the flight is estimated at sixty hours.

A NOTICE issued by the Air Ministry states that, subject to the provision that SOS messages from any quarter take precedence over other messages, the existing wireless services will be restricted to aircraft on the Continental routes, and preference will be given to certain classes of aircraft on certain sections of those routes until such time as additional provision has been made for direction-finding services. Ultimately, a separate wave length and separate groups of wireless stations will be allotted to the service of internal air lines.

THE Chairman of the Air League of the British Empire, Lord Mottistone, has outlined a project which aims at training 800 extra pilots every year in Great Britain. The Air League proposes to receive applications from young men who are prepared to pay weekly instalments towards the cost of their training and to double such instalments by means of a fund which it is hoped to raise for the purpose. The scheme will be operated through the flying clubs, and it is, therefore, hoped to afford facilities in most parts of the country. A fund of £10,000 will be required to realise fully the aims of the scheme.

THE two new Union Castle 25,000-ton passenger liners being built by Harland and Wolff, Ltd., are to be equipped with synchronous electric clocks. With this system, the frequency of the current supplied to the clocks is held to a predetermined value so exactly that it is possible to preset the frequency regulator so that not only do the clocks keep precisely together throughout the voyage, but may be caused to gain or lose any predetermined number of minutes during the succeeding twenty-four hours, according to the estimated speed and direction of the ship. Thus, the clocks will always show the correct solar time instead of having to be reset each day.

A QUESTIONNAIRE issued by the Coastal Trade Development Council to the principal firms in the coastal industry with regard to the number of persons of foreign birth employed on their vessels showed that of the entire fleets of the owners to whom the questions were submitted only eight vessels carried two or more foreigners in the crew. All the companies engaged in the coastal liner trade replied that they employed 100 per cent. British crews, and altogether forty-one concerns out of the forty-four who replied guaranteed their crews to be entirely British. Of the tramp owners questioned only three employed some foreigners in the crews of eight vessels, and most of these were stokers. The net result was that the percentage of foreigners in all the crews was infinitesimal.

# THE IRAQ OIL PIPE LINE

(For description see page 75.)

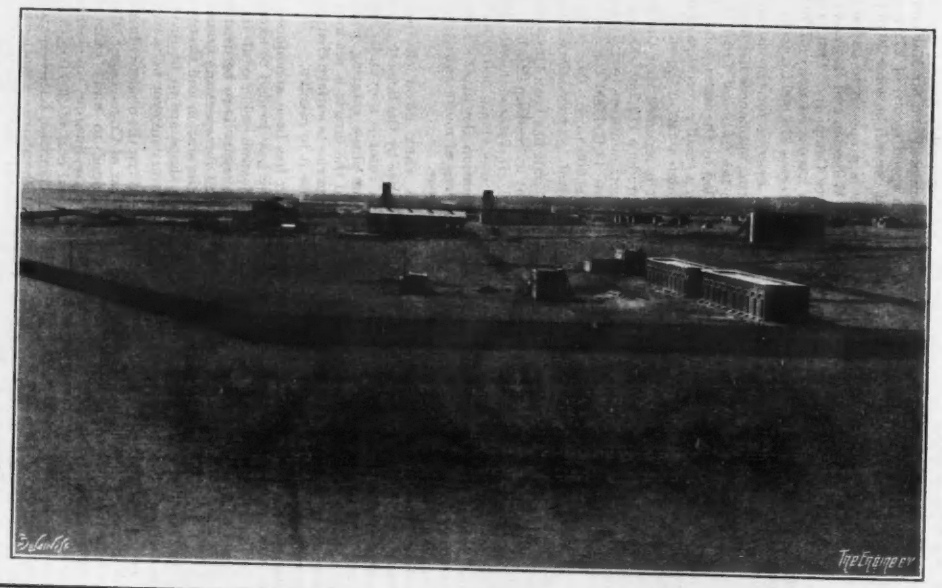
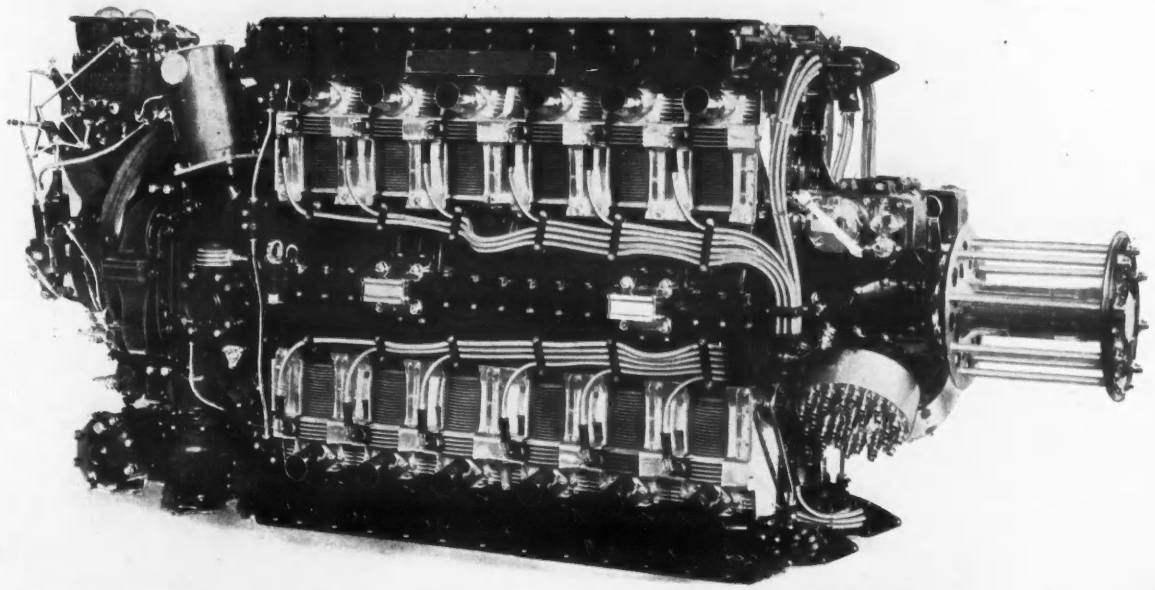
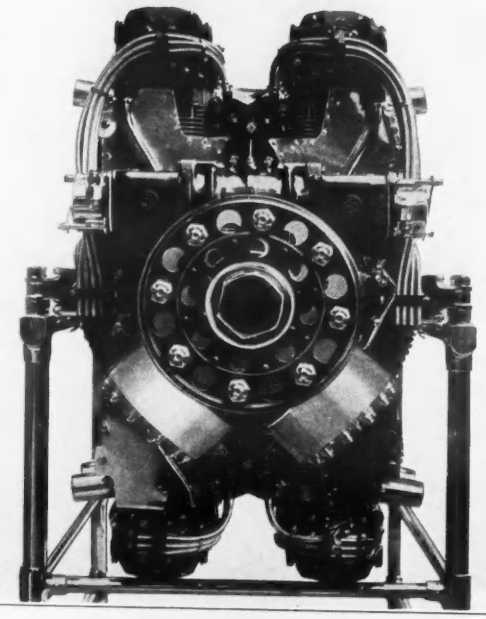


FIG. 1 (ABOVE):—BUCKEYE DITCHER AT WORK
FIG. 2 (BELOW):—TRIPOLI TERMINAL LOOKING INLAND

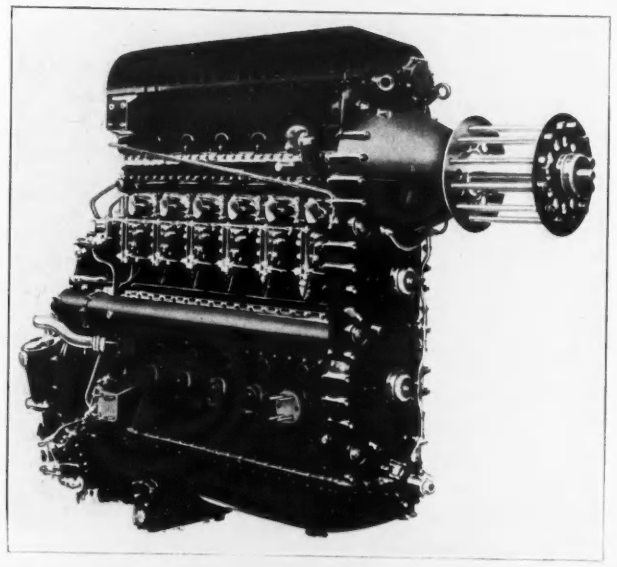
FIG. 3 (ABOVE):—PIPE-BENDING OPERATIONS
FIG. 4 (BELOW):—GENERAL VIEW OF T-4 STATION

# SOME BRITISH AERO ENGINES OF TO-DAY

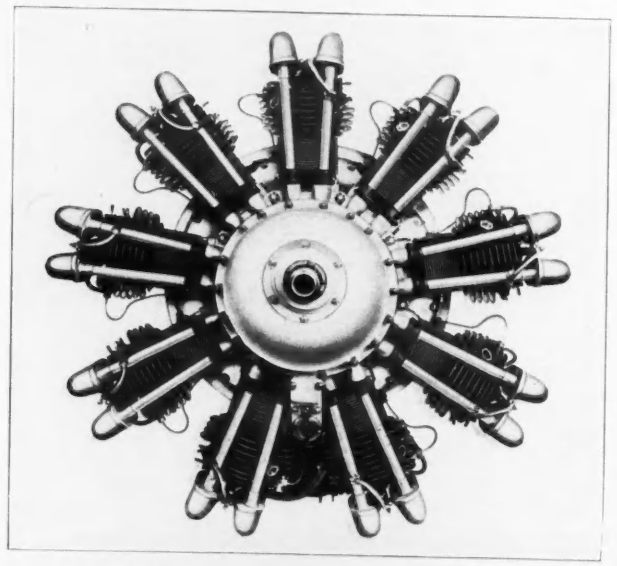




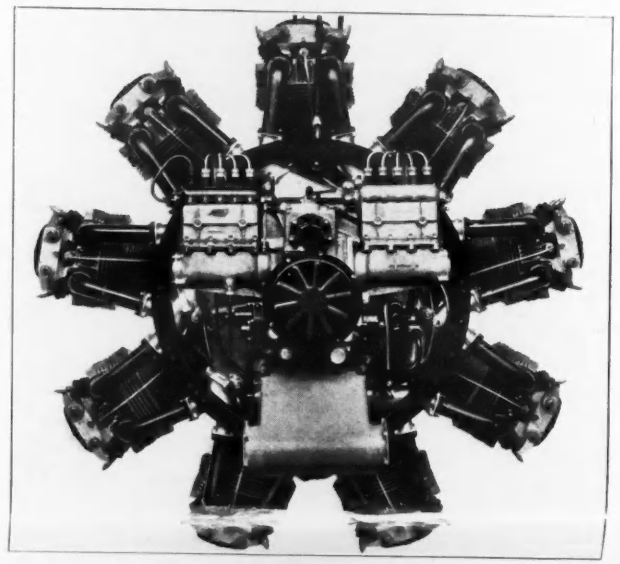
NAPIER-HALFORD "DAGGER" 24-CYLINDER AIR COOLED ENGINE



NAPIER-JUNKERS "CULVERIN" WATER COOLED C.I. ENGINE



WOLSELEY STATIC RADIAL 9-CYLINDER ENGINE

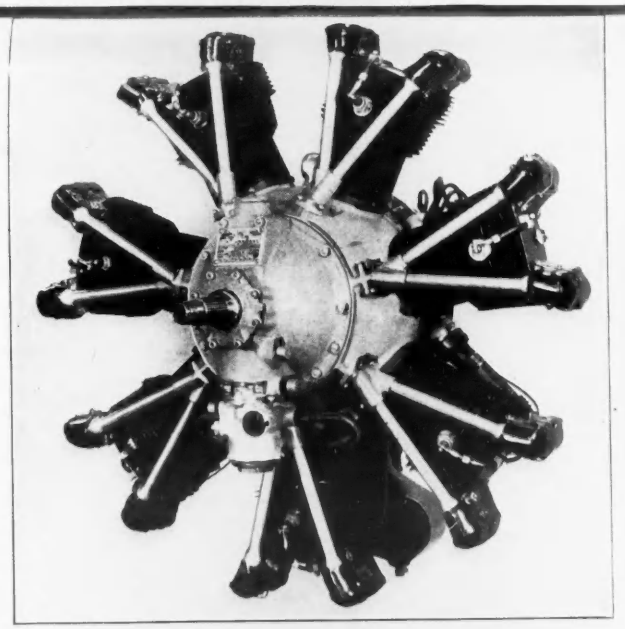


BRISTOL "PHOENIX" AIR COOLED C.I. ENGINE—REAR VIEW

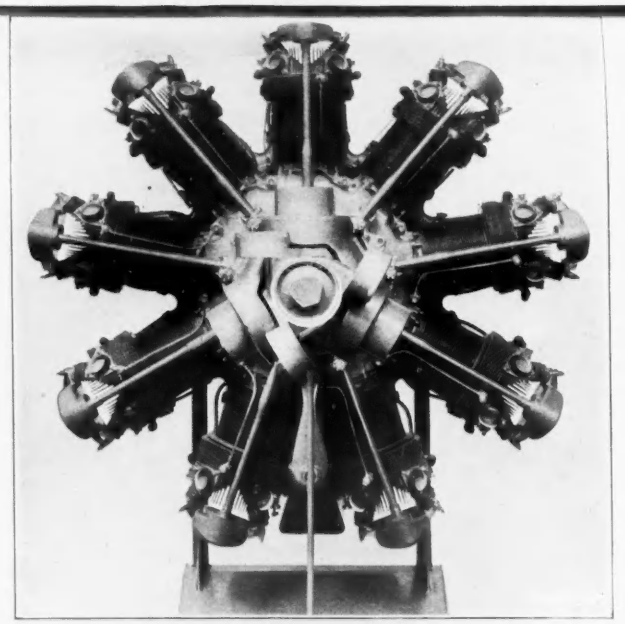
NAPIER-JUNKERS "CULVERIN" WATER COOLED C.I. ENGINE

WOLSELEY STATIC RADIAL 9-CYLINDER ENGINE

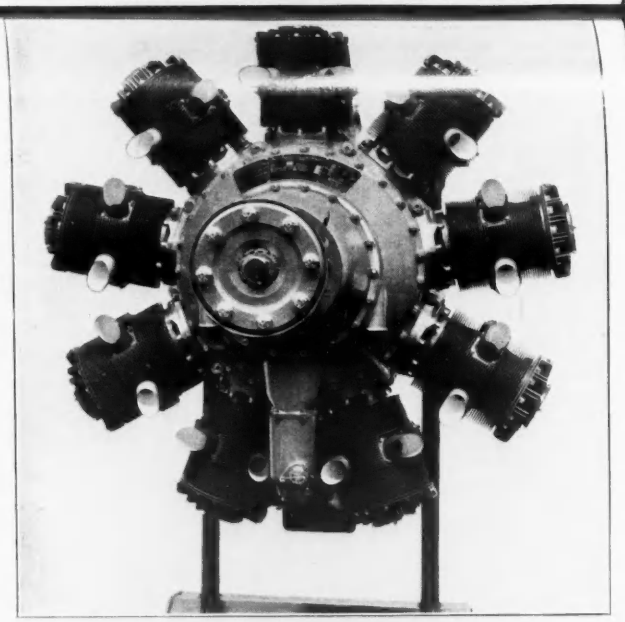
BRISTOL "PHOENIX" AIR COOLED C.I. ENGINE—REAR VIEW



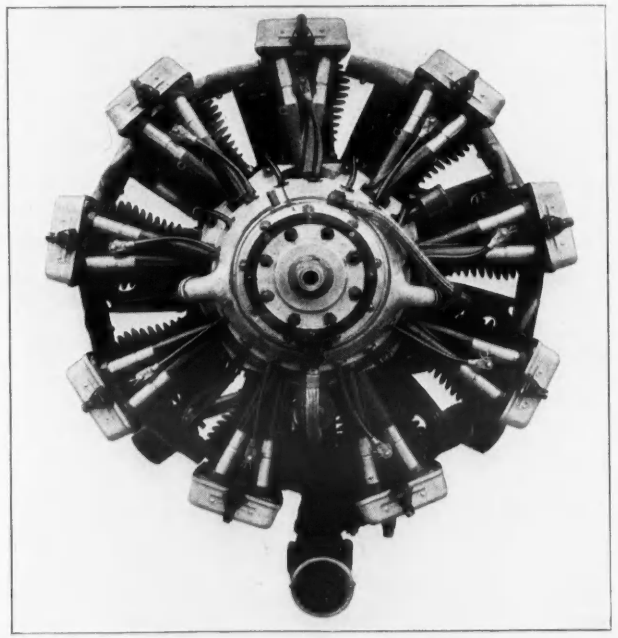
ARMSTRONG-SIDDELEY "GENET MAJOR" 7-CYLINDER ENGINE



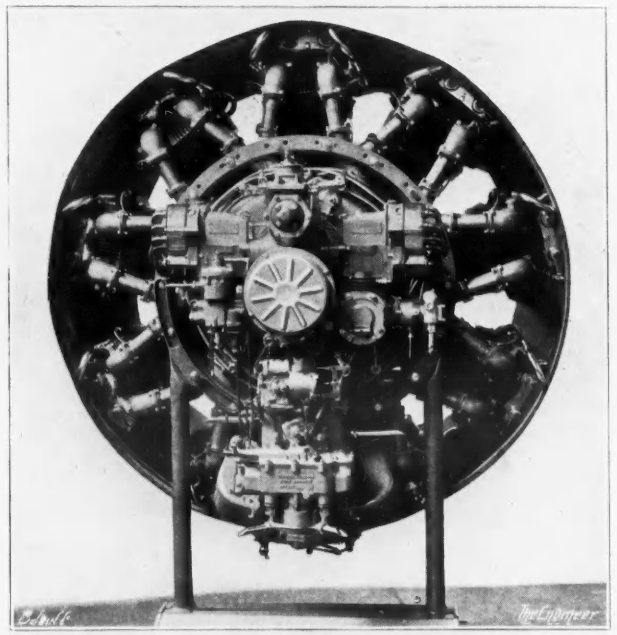
BRISTOL "PEGASUS" IV ENGINE FOR VARIABLE PITCH SCREW —FRONT VIEW



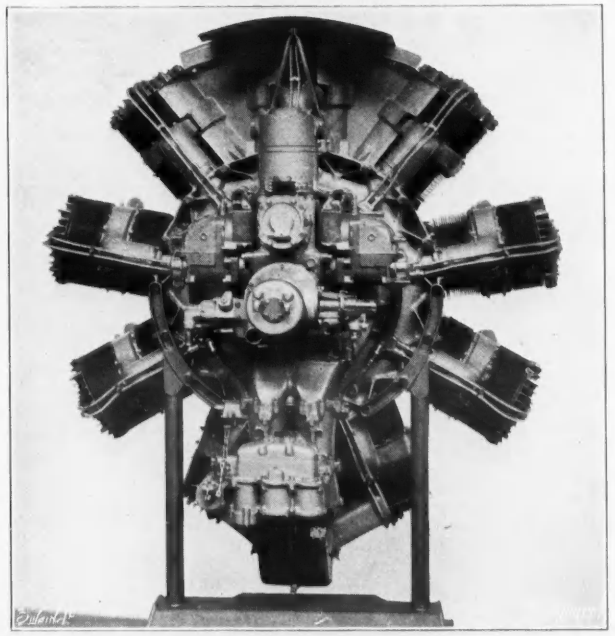
BRISTOL "AQUILA" SLEEVE-VALVE ENGINE—FRONT VIEW



BRITISH SALMSON "A.D.9.R." SERIES II ENGINE



BRISTOL "MERCURY" VI ENGINE—REAR VIEW



BRISTOL "PERSEUS" SLEEVE-VALVE ENGINE—REAR VIEW

# The Engineer

*JANUARY* 18, 1935.

VOL. CLIX. No. 4123


## Contents.


THE ENGINEER, January 18th, 1935. PAGE

A SEVEN-DAY JOURNAL ... 61
THE DEVELOPMENT OF PARSONS INDUSTRIAL TURBO-MACHINERY. No. II. (Illus.) ... 62
AERONAUTICS IN 1934. No. III. (Illus.) ... 64
THE DEMOLITION OF WATERLOO BRIDGE. (Illus.) ... 66
TEN MILLION TONS OF RUSSIAN PIG IRON ... 66
THE PHYSICAL SOCIETY'S EXHIBITION. No. III. (Illus.) ... 68
INTERNATIONAL CONGRESS ON LARGE DAMS ... 70
BOOKS OF REFERENCE ... 70
ROAD AND RAIL—MISCELLANEA—AIR AND WATER ... 71
LEADING ARTICLES—
The Pioneering Aspects of the Aeronautical Industry ... 73
Suburban Railway Electrification ... 73
PROTECTIVE MEASURES AT LEVEL CROSSINGS ... 74
SIXTY YEARS AGO ... 74
THE IRAQ PIPE LINE. No. I. (Illus.) ... 75
LETTERS TO THE EDITOR—
Broad Gauge Speed Record ... 76
High Rupturing Capacity Fuses ... 76
AMERICAN ENGINEERING NEWS ... 76
THE QUARTER'S SHIPBUILDING RETURNS ... 76
BRITISH RAILWAYS IN 1934 ... 77
A NEW ELECTRICITY METER FACTORY. (Illus.) ... 79
ENGLAND-SOUTH AFRICA AIR RACE ... 80
MARINE ENGINES BY A SUPERINTENDENT. (Illus.) ... 80
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 82
LAUNCHES AND TRIAL TRIPS ... 82
MARKETS, NOTES AND NEWS ... 83
CURRENT PRICES FOR METALS AND FUELS ... 84
FRENCH ENGINEERING NOTES ... 85
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 85
FORTHCOMING ENGAGEMENTS ... 86
CALENDARS ... 86
CONTRACTS AND ORDERS ... 86

TWO-PAGE SUPPLEMENT—SOME BRITISH AERO ENGINES OF TO-DAY.


### NOTICES TO READERS.

**** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

**** *For Subscription rates, see page 2 of Advertisements.*

**** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

**** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

## THE PIONEERING ASPECTS OF THE AERONAUTICAL INDUSTRY.

IN the march of engineering achievement progress in some new direction almost invariably opens up fresh possibilities of advance in existing developments. Perhaps that is merely another way of saying that no branch of engineering is completely isolated from all other branches and, therefore, that progress made in any one, however specialised the nature of that progress may at first sight appear to be, is bound, in some measure or other, to be applicable, ultimately, in fields additional to that which originally inspired it. This tendency of progress to spread its influence beyond its primary confines has been from the earliest days a marked feature of the history of engineering and of most other branches of activity based on applied science. In our own times we have seen it exemplified by the motor car. In many ways the developments made in the field of automobile engineering reacted upon the practice followed in older and apparently dissociated branches of the profession. An outstanding instance was the reaction on machine-tool design produced by the adoption of the change speed gear-box which the evolution of the motor car called into effective existence. More recently the same tendency has been seen at work in the field of radio communication. The developments made in wireless telegraphy and telephony have not only reacted on many aspects of light electrical engineering but have spread their influence to important sections of the heavy branches of the industry. The wireless valve, for instance, has inspired developments in the design of rectifiers, notably the introduction of grids into mercury arc rectifiers for voltage regulation or frequency conversion and for the inversion of direct into alternating current. In the most striking manner of all, perhaps, the tendency to which we have referred is to be observed to-day in the field of aeronautics. Were it our province to go outside the engineering aspects of our subject we might dwell upon the effect which aeronautics, and, in particular, the conception of streamline form which it has spread abroad, has had on art, architecture and adornment. Lying closer to our proper ambit we might point to the influence of aeronautics manifested in the stream-lining of motor cars, railway trains and the superstructures of ships, to the discovery of light alloys of high strength and their application to generally useful ends, and to other obvious examples of the manner in which this new branch of man's activity is affecting practice outside its own immediate sphere. In many less obvious or less familiar directions its influence merits formal recognition and study.

It is chronologically fitting that we should mention first the effect which the modern science of aeronautics has had upon one of man's oldest devices for performing work mechanically. If the windmill cannot be said to have entered upon its own again, it is certainly true to say that the application of aerodynamic principles to the design of its sails has at least saved it from complete extinction and has re-opened a useful, if limited, field for its employment. In a more important direction the study of the phenomena manifested by aerofoils has recently found a notable application. It has for long been a common practice to design the tractor screws or propellers of aircraft on the assumption that each successive section of the blade could be considered as an elemental aerofoil. The same method of design has now been applied to marine propellers and, with the guidance supplied by data of purely aeronautical origin, improvements of great practical value have been obtained. Figures received from shipowners show that, with propellers so designed, the fuel coefficient has been increased by from 10 to over 13 per cent., representing a saving in the annual fuel bill of from £700 to nearly £3000 with, in some cases, an additional gain in the way of increased speed. Less successful but no less interesting as another example of the application of aerodynamical principles to the propulsion of ships, we may recall the Flettner rotor ship designed to take advantage of the "Magnus effect," a phenomenon long known to students of aeronautics. Of practical processes which, originating within the aircraft industry, have spread to other branches of manufacturing activity there are numerous examples. When cellulose acetate was produced and applied in 1910 as a "dope" for tautening wing and fuselage fabrics the foundations were laid for an important development of the paint and varnish industry. To the special needs of the aircraft industry we may, too, trace the origination of the anodic process for the prevention of corrosion in aluminium alloys, and also the recent development in the use of lead-bronze as a bearing metal. In another direction the pioneer work of the aircraft industry deserves mention less perhaps because of the use so far made of it in other branches of engineering than because of the use to which it might and probably will be put. The evolution of the all-metal aeroplane demanded the initiation of certain entirely new workshop processes for drawing or rolling thin high-tensile steel or other metal strip into stress-resisting sections. Very difficult problems were at first encountered but to-day both the design and the production of such sections are thoroughly well understood and practised by a number of aircraft firms. Further, satisfactory methods of attaching other parts to them by bolting, riveting or welding are now established. This new technique presents the engineer with a greatly enlarged conception regarding the distribution of metal to withstand stress. There can be little doubt that in time it will find important application, outside the aircraft industry, as for example in the fabrication of light portable bridges and other structures. Of all the directions in which progress in the aeronautical industry has affected or is affecting progress in other branches first place must, we think, be given to its influence on the petrol and oil engine. Chiefly that influence has lain in the reduction of the weight required for the development of a given horse-power. To-day, to put it a little fantastically, six or seven hundred horse-power can be developed in a petrol engine occupying less cubical space than a Shetland pony. Well-tried, trustworthy engines of several designs are available which weigh just a little over one pound per horse-power of their output. It is, however, in connection with the compression ignition engine that the influence of the aeronautical industry is likely to have its most important external effect. From its earliest days this type of engine has been for nearly every purpose hampered by its excessive weight. Aero-engine manufacturers have now succeeded in producing water-cooled compression-ignition engines weighing about 2½ lb. per horse-power and air-cooled engines of slightly less weight. While the air-cooled compression-ignition engine is not likely to find any large field of application outside aeronautics the light-weight water-cooled type seems to have many openings awaiting it. Already, so it has been stated on good authority, the work done in connection with the evolution of the compression-ignition aero-engine has facilitated the application of heavy oil engines in omnibuses such as those now running in London. Quite recently the Air Ministry sanctioned the use of a heavily leaded petrol, of 87 octane value, in aircraft engines. Difficulties arose in adapting the engines to take the new brand of fuel, chiefly in connection with the cooling of the exhaust valves. The manner in which this particular source of trouble has been overcome by filling the hollow interior of the valve heads and stems with metallic sodium is mentioned in our review of aeronautics on page 64. Here we seem to have a particularly striking illustration of the way in which the aircraft and aero-engine industry is leading other and older branches of engineering along fresh paths.

It is not in any way surprising that aeronautics should have exerted and should continue to exert a striking and important influence on current practice outside its own immediate field. As an industry the scope of its work covers many interests and at many points it touches or rests upon other and diverse established branches of activity. Its special needs are numerous and of a highly exacting nature and must be fulfilled with a degree of perfection considerably beyond that which is sufficient in most departments of industrial manufacture. It is a young industry and has not yet passed through its first period of growth. New and strange problems are constantly being presented to it for solution and with youthful enterprise and courage it is not afraid to make new and strange experiments. Withal, it has attracted to itself an exceptionally able band of servants and workpeople of unusual skill and intelligence. Specialised as its products and its methods may at first sight appear to be the aeronautical industry by virtue alike of its history, its circumstances, its needs and its opportunities, is admirably situated to serve as a pioneer and leader to other industries. Fostered in many ways by Government assistance it may be, in some measure, the spoilt child of the industrial family but unlike most spoilt children it is giving back to the family in gratifying degree the fruits of its spoiling. It is one of the anomalies of the present industrial situation that while many old-established branches of manufacturing activity have suffered severely from the depressed state of trade the aeronautical industry, serving almost entirely to supply needs of a non-self-supporting kind, should have maintained a relatively remarkable state of prosperity. If anyone should be inclined to grumble at that fact and attribute it to direct or indirect subsidisation let him bear in mind the many practical benefits and developments which aeronautics has given, and will undoubtedly continue for a long time to give, to industry in general.

### Suburban Railway Electrification.

IN *The Times* of January 11th there appeared, on the middle page and in heavy type, a letter from Sir Philip Dawson. The writer found his text in the announcement that the London and North-Eastern Railway included in its programme for 1935 "four new complete trains for the Great Eastern suburban services," which, he suggested, implied that the densely populated areas served from Liverpool-street would have to be content with the present services and rolling stock. The question was then asked, Why does not the L. and N.E. Railway follow the example of the Southern?

The answer, we suggest, is to be found in the remarks made by Sir Herbert Walker, the general manager of the Southern Railway, at the annual dinner of the British Electrical and Allied Manufacturers' Association in 1933. He spoke of the success of electrification on the Southern, but added that it should not be assumed that equal results could be obtained from the electrification of railways in other parts of the country, or even in London. The Southern was a property which lent itself eminently to electrification. It had a much more uniform load throughout the day than any other system that he knew of, and being a "passenger line," the company had been able to devote the whole use of its railway to passenger traffic during the greater part of the day, and had not had to spend large sums on widening. Sir Herbert concluded by saying on that point that he did not know any other system in the country to which that applied. We venture to remind Sir Philip, that the London and North-Eastern intends, nevertheless, to follow the Southern Company's example in the matter of suburban electrification. Within the last two months a couple of answers to questions in Parlia-

ment reveal that fact. On November 12th, for instance, the Minister of Transport stated that the Joint Standing Committee of the four main line companies and of the London Passenger Transport Board had decided that, in the event of any electrification in the London suburban area of the L.N.E.R. being done, the lines based on Liverpool-street would have the priority over those radiating from King's Cross. Then, on December 17th it was stated that the scheme for electrifying the lines radiating from Liverpool-street was still under the consideration of the Joint Standing Committee. It is true that neither of these answers definitely commits the London and North-Eastern, but it is shown that the railway company has made further progress than Sir Philip Dawson's letter suggests.

One of the essentials in the London Passenger Transport Act, 1933, was that the receipts of the main line companies within the area covered by the Board, and the receipts of the Board from tube, omnibus, and tramway traffic should be pooled. The sequel can best be related in the words addressed by Sir Josiah Stamp at the London, Midland and Scottish annual meeting on February 24th, 1933. It was then observed that it had been very hazardous for a main line company to incur large capital expenditure in developing suburban lines with large terminal changes with no assurance that the returns on which it would rely would not be deleted, by mobile omnibus and coach incursions into those developments rendering the capital expenditure unprofitable. Under the Standing Joint Committee the responsibility for meeting particular demands in particular ways would fall on both parties, and railway outlay would be made with the requisite assurance that it was the most economic and satisfactory, and would receive its due protection against the duplication of capital and uneconomic competition, while abstinence from railway outlay in a particular service, in favour of some other form, would be an agreed abstinence without economic punishment. It is hardly necessary for us to point out that the pooling of receipts must be united to a pooling of expenditure, and agreement as to the proportions of the latter may be the reason for the delay in the L.N.E.R. electrification.

# Protective Measures at Level Crossings.

By R. A. RYVEL, M. Con. E., Assoc. M. Inst. C.E.

THE editorial note on "Railway Level Crossings" in THE ENGINEER of December 7th last, in which the whole position in regard to the protection of the public at these spots is explained in a very interesting manner, is confined, as regards measures of protection, to those which are provided in Great Britain.

The references to Colonel Trench's observation in regard to the Shapreth accident, and to his recommendation, endorsed by Colonel Mount, that additional safeguards should be provided, suggest that consideration might well be given to protective measures which have been adopted, or in some cases are on trial, in a number of European countries. These include some which are alternative to the provision of gates and gatekeepers, and others which provide additional safeguards at crossings so protected.

In a third class are equipments of a different character, which may serve as additional safeguards when means of protection in either or both of the other classes are afforded, or may suffice to protect crossings of railways with unimportant roads.

A point of technical interest, perhaps of statistical significance also in respect of previous accidents of a similar character, may be noted in connection with the accident at Wormley. That no passenger was killed was due to the facts that the engine rolled clear of the line, and the tender remained in such a position that the second coach, the nearest to the engine of those in which there were passengers, was not telescoped against either engine or tender. Had the line been in shallow or deeper cutting at the spot, the loss of life might have been very considerable, for either the engine or the tender, possibly both as one wrecked mass, would have provided a solid obstruction against which two, three, or more of the coaches would have been crushed lengthwise.

Consideration of means of protecting level crossings which are now being applied in the countries hereinafter mentioned, suggests that some of them would provide additional safety at public road railway crossings, and that the adoption of the simpler forms of such protective measures at the crossings of railways with occupation roads, defined tracks, and even field-to-field passages, might also be contemplated.

At some level crossings in Great Britain, light signals have been installed for the control of road traffic, but much more extended use has been made of such equipment in some Continental countries, where, also, other measures of protection, not employed at all in Great Britain, have given satisfaction.

From fully authoritative sources, information in regard to practice and to experimental equipment in those countries is available in reports presented at the International Road Congress held at Munich last September. These reports show that the subject is being considered in various aspects, in respect of directional, warning, and inhibitory road signs, automatic and train-actuated light and sound signals, measures relating to the provision of a clear view of the line and, in one country, the design, in plan, of the crossing itself.

Measurements in feet and miles, in the following paragraphs, are approximate conversions from metres and kilometres.

In Germany, the subject has been very thoroughly studied, the alternative and collateral provisions including applications of almost all typical methods. The law provides for the indirect control of the manner in which vehicles are driven towards a level crossing, since it is required that, unless it be undoubtedly evident that no train is approaching, the driver of a motor vehicle must proceed at a speed such that he can come to a stop before reaching the crossing.

There is also direct control of the manner of approach, when the crossing is closed to traffic, when a warning bell has sounded, or if a train is, in fact, approaching. All vehicles and animals must then be halted at the warning crosses which, it is required, must be erected on the approaches of roads to a level crossing. The responsibility in regard to whether a train is approaching is not lifted from the driver even when a gatekeeper has opened the gates.

The regulations provide that the provision of gates, a gatekeeper, or both, is obligatory under certain combinations of the three conditions-in-fact, the train speeds allowed at the crossing, whether a clear view of the line may be obtained from the road, whether the road traffic is intense or light.

Where there are gates they must be fitted with a warning bell which sounds at least ten strokes from 15 to 20 seconds before the gate is opened (or the barrier lowered), followed by at least five further strokes.

To a limited extent, automatic warning signals have been installed instead of gates and gatekeepers. The train turns on the warning light signal not less than thirty seconds before it reaches the crossing. During the interval between trains, lamps continuously flash an intermittent white light which, when a train is approaching, changes to red and flashes at twice the speed. The change of flashing speed is intended to meet the case of colour-blind drivers.

On branch lines, crossings not provided with gates are protected by intermittent strokes on a bell, or blasts of a whistle, operated by the approaching train.

Similar installations of light and of sound signals are employed in Austria, and their provision is contemplated in China, should experimental equipments in that country prove successful.

In The Netherlands thirty or more crossings have been provided with winking lights. Automatic signals are, in a few cases, provided for crossings of roads by light railways or electric tramways. These signals are of the semaphore type and the oscillating form.

In Denmark the Government disposes annually of a sum of 2,000,000 crowns in provisions for safety at unguarded crossings. The rules under which this money is expended provide that from a point on the road 98ft. from the railway line there shall be a clear view for 656ft. up and down the line, and at 33ft. distance for 984ft.

A notable safety measure which, it is believed, has been adopted only in Denmark is the turn-out—that is, the provision alongside the railway track on each side of a short length of roadway into which a driver may at the last moment turn his vehicle in order to avoid collision with a train. This measure is obviously more especially applicable where the road and railway cross at a sharp skew, while its value is greatest in foggy weather. Another provision of the Danish regulations is that at 330ft. from the railway a notice board must be erected ordering the reduction of the speed of road vehicles to 12½ miles per hour. Usually, the international sign, a locomotive under steam, is provided at unguarded crossings. There are similar provisions in The Netherlands.

In Italy there are 19,000 level crossings, more than 2500 of which are protected by gates or bars and gatekeepers, these including all crossings of railways by first-class national roads. Of the remainder, some 5200 are private, the owner keeping the key; 7900 are open and unguarded; and 3260 are protected by barriers operated from a distance. Of the open and unguarded crossings, some forty or more are now protected by automatic signalling devices, of the semaphore, the luminous signal, or the sound signal type. The new Road Code lays down regulations for the obtaining of unimpeded vision along the line and for the provision of suitable road signs.

It may be suggested that the various methods adopted in these countries are worthy of greater attention than is given to them in Great Britain; that their adoption as additional safeguards may be desirable at some level crossings on public roads, and that amongst the various systems described there are some which might be applied to unprotected crossings where the gates closing the road are opened by the drivers of vehicles. A train-actuated bell or lamp, sounding or alight during the last 500 yards of the train's approach, seems applicable to such cases, while a small gate-actuated signal, erected at a suitable distance along the line in each direction, would be an alternative or additional safeguard.

Although in many individual cases locks operated electrically from a signal-box could usefully be provided, the method is not so general nor so simple in its application as laymen seem to suppose. In normal cases control from two signal-boxes would have to be correlated or duplicate control provided. Further, at whatever moment the gates were to be locked a vehicle might have just been driven on to the line. An attempt to meet this by means of a device preventing one gate from being locked when the other is open and, at the same time, informing the signalman, would fail in the not uncommon case in which the driver takes his vehicle through one gate, fails to find a piece of stick to keep it open, shuts it, and goes to the other gate to open it. At many accommodation crossings there is seldom a witness of such a misdeed, so that penalties would prove ineffective as deterrents. If the gates were interlocked, so that both must be open or both shut, drivers could not proceed thus. The trapping of a vehicle on the line in the case of gates merely latched, as well as in that of locked gates, could be prevented, however, by removing the gates each to a little more than a lorry length from the line, and adjusting the fences to the new positions of the gate posts. The case of a vehicle stuck on the line through stoppage of its engine need not be considered in the present connection, but its contemplation suggests that action of some kind should be taken, in regard to crossings generally, to deal with this peril. It would be reduced by the interlocking of the gates, because the vehicle would then be driven, usually, right across both lines in one run.

## SIXTY YEARS AGO.

CONSIDERABLE caution and reserve should be displayed in reading and commenting upon a paragraph describing a "new electric light," which appeared in our issue of January 15th, 1875. According to this paragraph Professor Osborn of Miami University and Mr. William Day of Ohio had invented and exhibited a "new and intensely white" electric light. A thin ribbon of carbon, we recorded, was suspended between two platinum poles and was covered by a globe containing dry carbonic acid gas. The ribbon, we proceeded to explain, received an electric current from a battery and, while in the atmosphere of the gas, became brilliantly incandescent. The carbon was not consumed and the light was said to be perfectly constant. Professor Osborn had, at first, thought that it would be necessary to use very thin strips of carbon but the light, we reported, was now produced with much larger ribbons and with little combustion. So far the heat generated had never broken the small globe containing the ribbons. We concluded our note with the remark that as the light was constant and did not require the combustion of carbon it might prove much more useful to scientific lecturers than either the ordinary electric [*i.e.* carbon arc] or oxyhydrogen light, both of which were troublesome to handle. . . . It would be at least rash to describe this invention as a clear anticipation of Swan's and Edison's work the results of which were exhibited in public a few years later. At first sight we seem to see in it all, or nearly all, the essential features of the carbon filament electric lamp which shortly was to become a technical success, the only material point of difference being apparently the filling of the globe with carbon dioxide instead of exhausting it. Actually there is no evidence at all in the paragraph that Professor Osborn's light was in the form which we would now call a lamp. The wording employed leaves us open to believe that the light was simply an arrangement of laboratory apparatus designed to demonstrate that a carbon filament would glow without combustion when supplied with an electric current in an atmosphere of carbon dioxide. It is true that so far as Edison is concerned three years or so had still to elapse before he turned his attention to the incandescent electric light and more than three years before, abandoning platinum and other metallic wires, he concentrated on carbon filaments. But in Swan's case work with carbon filaments began in 1848 and continued until 1860 when it was abandoned because of the difficulty of producing a satisfactory vacuum and of the impossibility of obtaining a supply of electricity otherwise than from a battery. In 1877 Swan resumed his investigations for, by that date, the Sprengel mercury pump had been invented and the dynamo electric machine had been developed. His success lay in discovering a technically and commercially successful way of producing the carbon filaments and in applying a degree of vacuum to the lamps which would ensure a reasonably long life to the filaments. Professor Osborn appears to have been merely one of many who, even before Swan's time, had been seized with the idea of using carbon for the filament in electric incandescent lamps without attempting to solve the real problems involved in the commercial manufacture of a satisfactory lamp embodying the idea.

# The Iraq Pipe Line.

No. I.

AS recorded in one of to-day's Journal notes, on Monday last, January 14th, King Ghazi of Iraq formally opened the great pipe line, pumping, and oil storage system, which has been successfully carried out by the Iraq Petroleum Company, Ltd., an international company, representing British, American, French, and Dutch oil interests. We reproduce herewith a sketch map of the two pipe lines which run side by side from Kirkuk to Haditha, on the river Euphrates, where they separate, the northern or French section cutting across the desert to Tripoli, while the British section, continuing almost in a straight line, stretches in a south-westerly direction to Haifa. Some typical views of the pipe line, one of the pumping and one of the terminal station, are reproduced on page 72.

### AN HISTORICAL SURVEY.

Before dealing with some technical aspects of the undertaking, some short reference to the long history of the Iraq oilfield and its development is called for. From the beginning of history until well into the nineteenth century the oil resources of north-eastern Iraq were ignored, and practically unsuspected, save perhaps for the riverside peasant's use of a hand scoop of seepage oil for kindling his fire, rubbing his camel's back, or perhaps smearing with bitumen the skin of his river coracle. In the late decades of last century seepages were let year by year by the Government, and some primitive oil refining was begun locally. For many years the surface indications of sulphur, water gas, and bitumen had been noted and spoken of by travellers, and mention had been made of the "burning fiery furnace" of Baba Gurgur, which they doubtlessly connected with the Mosque of Daniel, the Prophet, at Kirkuk. At the beginning of this century, however, increasing interest was taken in the oil-bearing territories, alike by British, American, and German concessionnaires, and oil rights were freely canvassed in connection with the projected Baghdad Railway. Negotiations were delayed by the Turkish Revolution of 1908 and 1909, but by 1911 a British company, with German and later (through Sir Henri Deterding) Anglo-Dutch participation, styled African and Eastern Concessions, Ltd., had been formed, and is the direct ancestor of the Iraq Petroleum Company of to-day. Twice before the war and again in 1914 it was reconstructed and was then known as the Turkish Petroleum Company. Shortly before the outbreak of the war, following laborious negotiations by Mr. Greenway (now Lord Greenway), Mr. C. S. Gulbenkian, and Mr. H. E. Nichols, the company succeeded in obtaining from the Turkish Government the grant of a concession for the oil deposits of the Mosul and the Baghdad Wilayats. Owing to the war, however, eleven years elapsed between the Turkish grant and the signature of a regular convention by the Government of Iraq, which had taken over those territories. In March, 1925, the company, with powerful French and later American participation, began its work, and offices were established in Iraq, at Baghdad, Tuz, and Kirkuk, and geological surveys were began. Drilling started in April, 1927, and many test bores were completed. In October of that year the first oil was obtained from the gusher at No. 1 well at Baba Gurgur, and up to the spring of 1931 eight more wells were put down. The Convention of 1925 provided for the construction of a pipe line by the company, but no capacity was then named, and in January, 1928, a trans-desert survey was carried out by Lieut.-Colonel J. Hay, of the Anglo-Persian Oil Company. This work was continued until 1930 by British, American, and French engineers. In the autumn of that year, following field work by Mr. H. A. Hammick and Monsieur Parmentier, a decision was made to bifurcate the line at a point on the Euphrates, and to carry it to the sea through Syrian and Lebonese territory on the north, and through Trans-Jordan and Palestine on the south. In the mid-winter of 1930 to 1931 a further study of both lines was made by Mr. H. S. Austin, the president of the Ajax Pipe-Line Company, and Mr. H. M. Stevenson, of the Humble Pipe-Line Company, and Mr. Douglas, and the general hydraulic and mechanical data necessary for designing the line were obtained. The routes were first marked out with cairns by three survey parties controlled by Mr. Hammick and Mr. R. J. Johnson in the summer and autumn of 1931. Some important changes, both with regard to the development of the field and the pipe line, were made when the company's Convention of March, 1931, with the Iraq Government was signed. Under that Convention it was provided that the company should produce not later than August, 1931, plans for a pipe line system of a yearly minimum capacity of 3,000,000 tons. It was further provided that the work was to be completed by December 31st, 1935. The work has been accomplished at a cost, it is estimated, of no less than £10,000,000, and the company, its officials and engineers must be congratulated on the success of their work. Special mention must be made of the initiative and guidance shown by Sir John Cadman, who took a leading part in the work and who negotiated with the Iraq Government the Revised Convention of 1931, which to-day constitutes the company's charter. In the same year Conventions were successfully negotiated with the Governments of Palestine, the Lebonese Republic, and the State of Syria in order to permit the passage of oil through those territories.

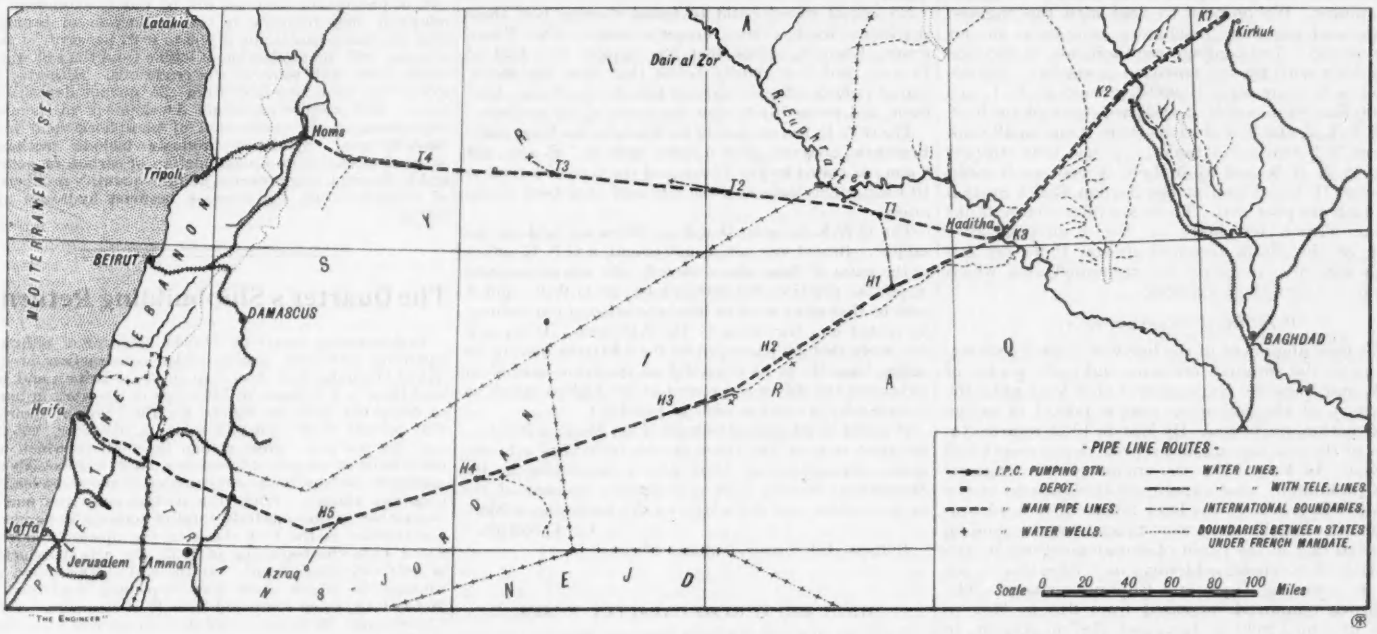



FIG. 5—SKETCH MAP OF THE ROUTES FOLLOWED BY THE PIPE LINES

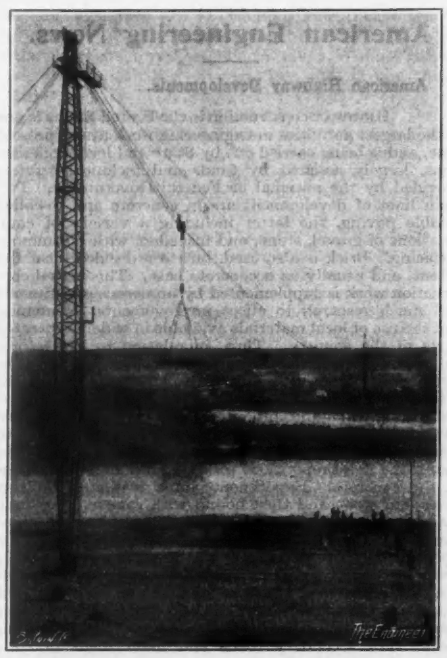


FIG. 6—CABLEWAY AT HADITHA

At Haditha the pipe lines separate, the northern line, which is to be of 12in. diameter, running to Tripoli, a distance of 560 miles, and the southern line, which is to be of 10in. diameter, running to Haifa, a distance of 532 miles. The pumping stations on the northern line are at Haditha, Kirkuk, Homs, and Tripoli, and on the southern line at Haditha, Rutbah, Mafrak, and Haifa. The pumping stations are designed to deliver 1,000 tons per hour, and the pipe lines are designed to deliver 4,000,000 tons per annum. The pumping stations are equipped with Diesel engines, and the pipe lines are laid underground, except where they cross rivers or wadis. The pipe lines are protected by a coating of bitumen and asbestos, and are buried at a depth of 3ft. to 4ft. The pipe lines are designed to operate at a pressure of 1,000 lb. per square inch, and are tested to 1,500 lb. per square inch before being put into service. The pipe lines are designed to operate for 20 years without replacement.

The design adopted provided for the construction of a line which would deliver half at Tripoli and half at Haifa, a daily average of 85,000 U.S. barrels, or 11,200 tons, of Kirkuk crude oil of 0·8416 density and 45 secs. viscosity (Redwood) at 70 deg. Fah. With the ascertained alignment and profile of the country, a line of 12in. pipe working at 700 lb. per square inch maximum pressure, and a 10in. pipe working at 880 lb. per square inch pressure, were found to meet the requirements. The pipes employed were to be of bell-ended seamless steel tubes, in lengths of 36ft. to 40ft. welded end to end over a chill ring. The 12in. pipe selected had a thickness of 0·33in., and a weight of 43·73 lb. per foot, while the 10in. pipe had a thickness of 0·307in., with a weight of 34·24 lb. per foot. For use on a single section 8in. pipe was chosen, with a thickness of 0·322in. and a weight of 28·25 lb. per foot. Special heavy pipe was specified for under-water work, and specially high pressure conditions, and was plain ended with clamps over all submerged joints. The 12in. pipe of this design was ½in. thick and weighed 65·45 lb. per foot, while similar 10in. pipe was 0·365in. thick and weighed 40·48 lb. per foot. The 12in. main pipe was supplied by the Comptoir Franco Belgo Sarrois, Stewarts and Lloyds, Ltd., the Bromford Tube Company, Ltd., the British Mannesmann Tube Company, Ltd., the Oil Well Engineering Company, Ltd., and certain German pipe-manufacturing firms, and the heavy 12in. pipe was made by Stewarts and Lloyds, Ltd., and the Bromford Tube Company, Ltd. The total 12in. pipe amounted to 5,362,000ft., with 152,693 sleeves, and 148,352 joints, and weighed 110,874 metric tons.

The 10in. main line pipe was manufactured by the British Mannesmann Tube Company, Ltd., Stewarts and Lloyds, Ltd., and the Oil Well Engineering Company, Ltd., together with German and American pipe manufacturers; the Oil Well Engineering Company and the National Tube Company, of America, supplied the heavy pipe. This 10in. pipe amounted to 1,018,000ft., with 28,250 sleeves and 27,259 joints, and weighed 15,068 metric tons. The 8in. pipe, supplied by Stewarts and Lloyds, Ltd., consisted of 78,000ft. of pipe, with 1340 sleeves and 2107 joints, and weighed 1059 metric tons.

It was decided to weld by electricity, and not to use gas, in conformity with practice during the past few years in American pipe line work. By this means the problem of transporting welding gas was done away with and, we are informed, the electric welding method was fully justified by the results obtained. The general lay-out of the pipe line and the stations is clearly indicated in Fig. 5. The double line from K–1 to K–3 is designed to operate normally as a single line, though provision has been made to operate the two lines separately. Oil is propelled

along the pipe lines by twelve pumping stations, the first of which is built on the edge of the Kirkuk structure, some 5 miles from Kirkuk. It is followed by K–2, 10 miles to the west of the Tigris, and K–3, 1½ miles east of the Euphrates. These are all double stations, each designed to pump 85,000 barrels, or 11,200 tons of oil per day.

After the bifurcation of the pipe lines at Haditha, the northern line passes through four stations, T–1 to T–4, each of which has a designed capacity of 42,500 barrels, or 5600 tons per day; while on the southern line there are five stations, H–1 to H–5, which are of the same capacity. A view of one of the completed stations, T–4, is reproduced in Fig. 4, page 72. The decision to install Diesel oil engines to drive the pumps was influenced by the general scarcity of water and the ease of obtaining oil fuel, and it was found that a total of forty-five four-stroke cycle oil engines, each of 500 b.h.p., operated at between 210 and 330 r.p.m. would supply the necessary power. We propose to deal with the engines, pumps and auxiliary machinery equipment in our next article. The tankage requirements of the line were dealt with by the provision of six large 93,000-barrel or in some cases 10,000-ton tanks at K–1, two 30,000-barrel tanks at K–2, and five large tanks at K–3. At T–1, T–2, and T–4 stations there is one small tank and at T–3 two small tanks. At the four stations H–1, H–2, H–3, and H–5 there is one small tank, while at H–4 and also at the Jordan Relief Station two each are provided. There are fifteen large tanks at the Tripoli terminal—see Fig. 2 on page 72—while at the Haifa terminal station there are ten tanks with five more on the reclaimed area which adjoins the new Haifa harbour.

### PIPE LINE CONSTRUCTION.

The final alignment of the line was made by survey parties in the summer, autumn, and early winter of 1931, and from the November of that year until the February of the following year a period of active construction was begun. By March, 1932, representatives of the engineering and service departments had arrived. In May, 1932, the engineers were engaged in a preliminary and experimental clearance in the lava country, which was later followed by road construction. Finally steps were taken to make good an essential link in the chain of communications by the erection of overhead cableways or "Blondins"—see Fig. 6—over the Tigris and Euphrates rivers. The workmen employed increased from 916 in May to 1735 in June, 2620 in July, and 4787 in August, in addition to which there were the European engineers and supervisors. Such important matters as construction depôts, river crossings, and road construction were carefully considered, as also were the telephone and telegraph services, living, and hospital accommodation. For transporting pipes and material use was made of the available railway services, but in addition a large fleet of motor transport vehicles had to be established. These included large-capacity trucks for main pipe haulage, medium and small-capacity vehicles for service operation, motor tank wagons for the conveyance of water and petrol, and passenger vehicles for the use of the executive and supervisory staffs. The vehicles were supplied by leading British, American, and Continental motor manufacturers. We show in Fig. 1 one of the Buckeye ditchers used for making the trench in which the pipes were laid, and in Fig. 3 a typical pipe laying and bending operation. Special features of the transport vehicles were the large tire contact area and the generous ratio of tire capacity to weight. Extensive use was made of fully articulated vehicles. In all cases provision was made for an unusually large power weight ratio and air filters for the engines. The work of laying, welding, and burying the main pipe lines was preceded by the laying of the line under the Euphrates and Tigris rivers and was entrusted to four gangs. After the main pipe line was finished the welding operatives occupied themselves with the tank and pump house connections, the heat exchangers, and the floating tank roofs, the welders being employed for some months in 1934. Besides the telephone and telegraph communication services there was a wireless service and an aircraft communication service, while a complete system of water supply was created by drilling wells and installing pumping plant and pipe lines from the great rivers.

*(To be continued.)*

## Letters to the Editor.

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### BROAD GAUGE SPEED RECORD.

SIR,—Many readers of THE ENGINEER know that for well over eighty years a claim has been made that the 9.50 a.m. broad gauge express from Paddington on May 11th, 1848, ran to Didcot in 47½ minutes, start to stop; an average speed of 66·8 m.p.h. A card giving the name of the engine, driver, &c., was distributed, but no reason was given for the acceleration of the train on this occasion.

On the afternoon of May 10th, 1848, a fatal accident occurred at Shrivenham to the up Exeter express, and the inquest was held the next morning. In a periodical published at the time it was stated that Brunel and Saunders represented the Great Western Railway at the inquiry.

It struck me that they travelled down by the 9.50 express, and to enable them to be present at the inquest at the earliest possible moment the driver was instructed to travel as fast as possible, the result being the record run under discussion.

I inquired of Sir James Milne, the general manager of the G.W.R., if documents in possession of the company could throw light on the matter. He most courteously gave instructions to his central record office to make research. This was done, and Sir J. Milne has kindly sent me the report of Mr. D. V. Levien, detailing the result of the research.

From this it appears, according to *The Times*, that the G.W.R. was represented at the inquest by C. Russell (chairman), C. A. Saunders (secretary), S. Clark (superintendent), D. Gooch (locomotive superintendent), and H. Lane (resident engineer); but Brunel is not mentioned.

No official record could be found showing how these gentlemen reached the coroner's court. *The Times*' report, however, states that the inquest was held at 10 a.m., and that shortly before that hour the above-named railway officers "arrived here by the 8 a.m. down train, and proceeded to view the scene of the accident."

The G.W.R. has no copy of its timetable for May, 1848; Bradshaw, however, gives a down train at 7.45 a.m., not 8 a.m., as stated in *The Times*, and the time of arrival at 10.4 a.m. This looks as if the 7.45 may have been accelerated.

The G.W.R. records, therefore, throw no light on the subject. Brunel was not, I understand, a G.W.R. officer in the sense of those above named. He was an engineer in private practice, but retained by the G.W.R., and it may be that other work or late intimation of the accident prevented him travelling by the 7.45 train. If so, is it not likely that he journeyed by the 9.50 train, driving the engine himself—as he often did on special occasions—or instructed the driver to proceed at the highest speed, so as to reach the court as early as possible?

It would be interesting to know if the *Morning Herald*—the great rival of *The Times* at that period and a broad-gauge protagonist—or local papers circulating in the Shrivenham district, give any detailed account of the inquest, which may throw light on this interesting subject.

G. A. SEKON.

Burgess Hill, Sussex, January 14th.

### HIGH RUPTURING CAPACITY FUSES.

SIR,—Referring to Mr. Anderson's letter in your issue of January 4th, the answer to the paragraph dealing with the inductance of the fuse and circuit breaker test circuits is that the inductance of the two circuits was identical until the circuit breaker contacts had parted and introduced the blow-out coil inductance into the circuit.

A. M. POOLEY,
Manager, Fuse Gear Section.

The English Electric Company, Ltd.,
Stafford, January 8th.

## American Engineering News.

### American Highway Developments.

HIGHWAY construction in the United States is one of the largest activities in engineering work at the present time, and is being carried out by State and local organisations, largely assisted by funds and technical services provided by the national or Federal Government. Two main lines of development are in concrete and so-called flexible paving, the latter including a variety of combinations of gravel, stone, and macadam with bituminous surfacing. Brick is also used, but to a decidedly smaller extent, and usually on a concrete base. This actual construction work is supplemented by numerous experiments and much research to effect improvements, economies, and the use of local materials available in widely separated parts of the country. Thus, in relation to the fatigue behaviour of concrete, research studies show that when the stress under loads does not exceed 50 per cent. of the ultimate strength, or when the safety factor is 2 or more, the paving will stand unlimited repetitions of stress without failure. With this factor above 2 the stress repetitions benefit and strengthen the concrete, while when it is less than 2 the stress repetitions will cause failure and breakage of the concrete. Experiments on a test road built of macadam stone and then bound with cement have indicated that such construction may be as strong as mixed concrete. The relative economy of the two will depend upon the conditions prevailing at any proposed location. Even for traffic as low as 100 vehicles per day, concrete may be economical when its annual cost is considered, based upon life expectancy, and allowing for depreciation, interest, maintenance, salvage value, and vehicle operating costs. For secondary roads and main roads of comparatively light traffic there is extensive use of gravel and water-bound macadam with a bituminous surfacing 2in. to 5in. in thickness. Natural soils are sometimes suitable when well compacted and drained and impregnated with bituminous materials or mineral salts.

### Chemical Engineering Developments.

A recent review showing how changes in various industries in the United States have resulted from the application of chemical research, dealt largely with its relation to the steel industry. In light metallic alloys the principal are those of magnesium and aluminium. Production of magnesium was about 800,000 lb. in 1932, but its main use and value is in giving certain desirable properties to metal with which it is alloyed. Thus, an alloy metal of 42,000 lb. tensile strength has only one-fourth the weight of mild steel with 60,000 lb., while on the basis of equal weights, the alloy would have a much greater strength. It is predicted that further research will result in a considerable increase in the use of magnesium alloys. While aluminium-magnesium alloys show the greatest increase in consumption, there are alloys of aluminium with copper and zinc. In most cases the maximum benefit from the alloys is obtained by heat treatment of the metal. Striking developments have been in the use of light and strong aluminium alloys in bridgework, railway rolling stock, and architectural features of buildings such as sills, spandrel panels and decorative features. The function of the chemical engineer is to lower the cost of production of aluminium, since 4 tons of bauxite produce but 1 ton of the alloy metal. In stainless steel an iron alloy containing 18 per cent. of chromium and 8 per cent. of nickel is a recent development, and has more than twice the strength of ordinary carbon steel. Such metals can be rolled, forged, or cast, and with lower prices resulting from decreased cost of production their use will be widely extended. A relatively new industry is the production of bromine from sea water containing 0·006 to 0·02 per cent. of this element, and the production of iodine from the salt water which flows with some of the crude oils. Hitherto, all iodine has been obtained from the nitrate deposits of Chile. Still another important development in chemical engineering is the production of phosphoric acid in a blast-furnace. Synthetic products include methanol or wood-alcohol from a combination of carbon monoxide and hydrogen under pressure, and the quantity production of ammonia from the reaction between hydrogen and nitrogen.

## The Quarter's Shipbuilding Returns.

THE statistics issued by Lloyd's Register of Shipping regarding merchant vessels under construction at the end of December last show that in Great Britain and Ireland there is a decrease of 7462 tons in the work in hand, as compared with the figures for the previous quarter. The present total—596,834 tons—is, however, 265,293 tons (80 per cent.) greater than the tonnage which was being built at the end of December, 1933, and exceeds the aggregate tonnage under construction in the seven leading countries abroad. While the decline since the end of September in the quarterly total of tonnage in course of construction is the first check to the upward tendency noted since the beginning of 1933, the actual reduction is relatively insignificant. At the end of December, the tonnage on which work was suspended amounted to 26,688 tons, being composed entirely of steamers. About 81,000 tons—13·5 per cent. of the tonnage now being built in this country—are intended for registration abroad or for sale.

The tonnage now under construction abroad—654,888 tons—is about 52,000 tons less than the work which was in hand at the end of September, 1934, but is, nevertheless, 229,000 tons greater than the figure for December, 1933. Tonnage, included in the total in hand abroad, on which work has been suspended amounts to 2800 tons of steamers and 6378 tons of motor ships. The leading countries abroad are:—Germany, 139,611 tons; France, 120,952 tons; Japan, 104,640 tons; Denmark, 78,630 tons; Sweden, 60,140 tons; and Holland, 48,333 tons.

The total tonnage under construction in the world (excluding Russia, for which no figures are available) amounts to 1,251,722 tons, of which 47·7 per cent. is being built in Great Britain and Ireland and 52·3 per cent. abroad. The world total shows a decline of 60,000 tons from the figures at the end of September last, but is 494,445 tons (65 per cent.) greater than the tonnage being built at the end of December, 1933.

In Great Britain and Ireland 93,428 tons were commenced during the last three months, showing an increase of 16,517 tons compared with the corresponding total for the September quarter. During the quarter ended December, 1934, 206,527 tons were launched in Great Britain and Ireland, an increase of 23,105 tons as compared with the previous quarter. Similar figures for abroad are 109,469 tons commenced and 177,855 tons launched, showing a decrease, as compared with the previous quarter, of 71,708 tons in the tonnage commenced and an increase of 54,480 tons in the tonnage launched.

Steam and motor oil tankers under construction in the world amount to forty-four vessels of 338,070 tons, of which thirteen vessels of 94,000 tons are being built in Great Britain and Ireland, eight vessels of 57,450 tons in Germany, six of 52,900 tons in Denmark, six of 40,270 tons in Holland, four vessels of 34,700 tons in Sweden, and two of 18,600 tons in the United States of America. Of the 596,834 tons under construction in Great Britain and Ireland at the end of December, 294,137 tons consisted of motor ships, while at the same date the motor ship tonnage being constructed abroad (404,631 tons) was 155,729 tons in excess of that of steamers.

The vessels being built in the world at the end of December include seven steamers and twenty-one motor ships of between 8000 and 10,000 tons each; three steamers and nineteen motor ships of between 10,000 and 20,000 tons; and four steamers and two motor ships of 20,000 tons and upwards.

A table respecting marine engines shows that the horse-power of steam engines now being built or being fitted on board amounts to about 749,000 h.p. This figure includes fifty-seven sets of turbine engines of about 647,000 s.h.p. The horse-power of the steam reciprocating engines, about 102,000 h.p., amounts to 7·1 per cent. of the total horse-power of marine engines now being built in the world. The figures for oil engines aggregate approximately 697,000 h.p. Of the merchant shipbuilding in hand throughout the world at the end of December, 883,190 tons, or nearly 71 per cent., are being built under the inspection of Lloyd's Register. Of this total, 549,818 tons, representing more than 92 per cent. of the tonnage being built there, are under construction in Great Britain and Ireland; while of the tonnage being built abroad, 333,372 tons, or nearly 51 per cent., are being constructed under the inspection of Lloyd's Register.

# British Railways in 1934.

BY the continued courtesy of their chief engineers, we are enabled to give the following report of the activities of British railways during the past year. It may be useful if we observe that the annual reports for the year 1933 showed that the four grouped companies proposed to spend during the past year the sum of £2,478,000 from capital on lines open for traffic. That amount was made up of the following sums :—L.M.S., £754,000 ; L.N.E.R., £404,000 ; G.W., £420,000 ; Southern, £900,000.

The following progress is now reported :—

**London, Midland and Scottish.**

*Works Completed.*—The additional station at Upminster Bridge was opened on December 17th. The new loop at Laindon, which will enable trains to start from and terminate at that station, together with the new station buildings ; the remodelling of the locomotive yard at Shoeburyness, and the new passenger and goods station at Hadleigh were finished. A year ago we reported that in the reconstruction of the floor of Sharnbrook original viaduct four spans had been built. The other five have since been completed. We also mentioned the modernisation of the locomotive running sheds at various places. Of the places then named, the work at Rugby and Farnley has been completed. This modernisation will permit of a much quicker turn round of the locomotives at the sheds and their consequent increased employment in traffic. Additionally to the two completed, five approach completion and fourteen others are in hand.

Additional facilities have been provided at various stations and signal-boxes between Preston and Blackpool and Fleetwood, in order to cope with the increasing passenger traffic.

Of the forty-eight bridges at various places that needed strengthening, in order to permit of the running of heavier engines on the routes concerned, only one remained to be dealt with, and the contract for that has now been let.

*Works Begun.*—A new station, to be known as Elm Park, between Dagenham and Hornchurch, is being built. The accommodation at Wembley is being improved ; a contract has been let for rebuilding the station frontage and providing a new concourse and entrance. What is known as the New Viaduct, at Sharnbrook, which was built in 1879 and parallels the original viaduct mentioned above, consists of nine spans of varying lengths. The floor under the goods lines is being replaced by a new steel floor which is being welded to the top flanges of the existing main girders. Five spans have been completed, and the work on the four remaining spans is in hand. Thirteen bridges between Mangotsfield and Bath are being strengthened to admit of the running of heavier engines.

**London and North-Eastern.**

*Works Completed.*—A year ago we reported that the Gidea Park and Shenfield widening was opened on January 1st, 1934. Since that date the reconstruction of the stations at Harold Wood, Brentwood, and Shenfield has been completed. The extension works at Parkeston Quay were officially opened for use on October 1st. The new quay is an extension of the old one, built in 1883, and extended in 1906. The new extension is 1120ft. in length and 146ft. in width ; it has been constructed of reinforced concrete, and is connected to land on the up-river side by two reinforced concrete viaducts, each 500ft. long, one of which carries a single passenger line leading to the new station on the pier extension, and the other a double line for goods traffic. The work involved considerable alterations in the adjacent marshalling yards and sidings, and seven additional sidings, capable of accommodating 387 additional wagons, have been provided. The reconstruction, in reinforced concrete, of a portion of the north quay of the trawl dock at Lowestoft Harbour was finished. This is part of the scheme for the general reconstruction of the quay walls of the dock.

*Works Progressing.*—It is hoped that the remodelled station at Fenchurch-street, begun in 1933, will be completed by Easter, 1935. This work, which is intended to accelerate and considerably improve the train service, involved extensive alterations to the bridges and permanent way between Fenchurch-street and Leman-street stations. It includes the reconstruction of station buildings and platforms, installation of multiple-aspect colour-light signalling in place of mechanical signalling, and provision of electrical point operating gear and an all-electric signal-box. The bridgework and the greater part of the permanent way lay-out has been completed.

In connection with this scheme, the company has renewed the superstructure of the bridges over Coopers-row, Crutched Friars, Vine-street, and Minories, and has constructed a passenger subway to connect the platforms and to give access to them from the new station entrance in John-street.

The down marshalling yard between Dinting and Mottram continued to make progress and now approaches completion. The diversion and straightening of the main line, covering a length of 55 chains, was completed during the year. The earthwork and bridges in connection with the marshalling yard are completed, the permanent way is being laid down, and the electro-pneumatic installation for working the yard points is being fixed. The yard will have eight reception sidings, each to hold an eighty-wagon train, and twenty marshalling sidings, each of sixty-five wagons capacity.

The replacement of the wagon shops at York, which, as related herein a year ago, were destroyed by fire, and the improvement of some of the adjacent shops, are nearly completed. This work has permitted the reorganisation of the working of the York wagon works, so as to facilitate the more rapid handling of wagons.

In our annual review for 1931 we said that a big development was in hand at Hull. A new inward marshalling yard was being constructed on the north side of the Priory Main Yard. It was to be approached from the west by six reception lines, each holding eighty wagons. The trains, on arrival, were to be hump-shunted into thirty sidings, each accommodating sixty wagons. The work was suspended in 1931, and was not mentioned in our reviews for the years 1932 and 1933. It was, however, resumed in July last, and the work is in hand for coupling up the points of the hump yard to a control tower and the provision of four Frölich rail brakes.

The reorganisation of the shops at North-road, Darlington, is now nearly complete. The new engine weigh-house was brought into use last year, and a new joiners' shop and a new press shop erected. At the additional station at Monkseaton, which, as we said a year ago, was erected in a month, the station buildings have been brought up to road level, and it is expected that the whole of the work will be finished in the coming spring.

Water-softening plants have been erected at Bawtry, Doncaster, Offord, Langley, King's Cross, and Hitchin. Similar plant is being put down at Retford, Newark, Werrington, Grantham, and Frodingham. Reinforced concrete has been used for the foundations and substructures in nearly all cases.

**Great Western.**

*Works Completed.*—The improvements on the Minehead branch, mentioned herein a year ago, are in operation. The up line portion of the bridge carrying the Great Western over the Southern Railway at St. Budeaux, Plymouth, has been reconstructed. This bridge was built by Brunel in 1859, and consisted of two wrought iron bowstring girders, 154ft. 9in. long and 16ft. 6in. deep at the centre, with wrought iron cross girders and a timber floor. The girders in the new structure are 120ft. long and 15ft. deep at the centre ; the floor consisting of underslung cross girders and steel plates. The College Wood viaduct on the Falmouth branch—the last link in the chain of timber viaducts constructed by Brunel in the West of England—has been replaced by a masonry structure built alongside the timber viaduct, which was 974ft. in length. The great improvements in the approaches to the Cardiff General Station were said in our last Annual Article to have been practically completed then. They were finished during the year.

The programme at Barry Docks for the provision of 20-ton hoists was completed by the bringing into commission of hoists Nos. 22 and 24 in No. 2 Dock. In each case the steel and timber viaducts have been replaced by concrete structures, and extensive alterations made to the jetties carrying the hoists to make them suitable for those of 20 tons capacity. The new movable 20-ton coal hoist at Tennant's Lay-bye, King's Dock, Swansea, comprises a movable hoist capable of movement to any point on a 250ft. long track which has been provided. This work necessitated the construction of extensive piled reinforced concrete foundations for the hoist track and elevated traverser gantry, together with extensive earthworks for the feed roads, abutments, and bridges, &c. There was also finished the renewal of the outer west roundhead at King's Dock, Swansea. It is an example of a modern form of construction that has not hitherto been used on the Great Western Railway Company's system for so large a work. The old structure comprised a massive timber-braced jetty, to renew which in similar form would have been very costly. The new structure consists essentially of a continuous wall, constructed of interlocked Larssen steel piling, forming the front of the roundhead, held back by numerous tie bars up to 100ft. long, secured to anchorages embedded in the ground, the whole of the space between the back of the piling and the ground being filled up with suitable material. The front of the piling is protected from damage by vessels by close timber fendering.

No. 4 jetty at Fowey was built in 1873. It was constructed of timber piles and timber superstructure, the jetty head being constructed of a pile cage. A new jetty, 145ft. long, is constructed on six cylinders, which were sunk by means of compressed air. The deterioration of the piles, which primarily necessitated the reconstruction, was largely due to the Toredo worm, which attacked the piles below high water level. The roof over Wolverhampton Station was constructed about 1874 and was of the over-all type, the principal members being twenty-three crescent-shaped trusses of 113ft. clear span and 25ft. deep. It has now been taken down, having been replaced by verandah coverings.

*Works Progressing.*—The equipment of the creosoting depôt at Hayes, now over fifty years old, with modern plant made good progress. The improvements outside Bristol Station, in connection with the reconstruction of Temple Meads Station to nearly three times its original size, have advanced. The quadrupling of the line between Filton Junction and Portishead Junction, forming part of these works, and the greater part of the new station has been completed.

Swansea, High-street, Station has been under construction for some years, and is now a through station on the main line. The former station had two main platforms, 360ft. and 580ft. long respectively, and a bay line 70ft. long. The provision in the new station of four platforms, each 900ft. long and a bay 600ft. in length, is nearing completion. The public access to the new station is of suitable proportions and the buildings mark another step forward in station architecture.

**Southern.**

*Works Completed.*—The enlargement of the locomotive depôt at Longhedge to permit that at Battersea to be closed was completed during the year. Two of the former sheds at the latter place are being converted into repair shops for road vehicles, both motor and horse-drawn. The improvements at Dartford Station are finished.

The electrification of the lines to Sevenoaks, *viâ* Chelsfield and *viâ* Swanley, involving the conversion of 24¾ miles and the provision of a control room at Swanley, and of six sub-stations, was opened on the 6th inst.

The stations at Hayes, Seaford, and Hampton Court and the goods stations at Cosham, Bexley Heath, Eltham, Sidcup, St. Mary Cray, Worcester Park, and West Worthing, and the goods yard at Hounslow, have all been reconstructed.

The Allhallows branch, which was opened as recently as 1932, was converted from single to double line in time for the summer traffic.

The improvements contemplated at Tonbridge were described a year ago. The track alterations have been completed and the station buildings are being modernised. The work at Dover, consequent on the provision of the Dover–Dunkirk train ferry, has been actively in hand. One of the disused sheds at Bricklayers' Arms is being adapted for use by the Customs authorities for the examination of goods conveyed in wagons from the Continent by the train ferry.

The enlargement of Southampton West Station makes progress. The scheme provides for four through platform lines with new station buildings on the down side and a reinforced concrete bridge for foot passengers and luggage. The line thence to Millbrook is being widened from two to four lines of way and connections, together with an enlarged station, provided at Millbrook with the lines on the new docks.

*Works Commenced.*—The stations at Raynes Park and Kingston are being improved.

The electrification of the lines to Seaford, Eastbourne and Hastings, which involves the conversion of 131 single track miles, together with the provision of a control room at Ore and of sixteen sub-stations, makes progress. The present Cooden Halt will be reconstructed as a modern station. At Lewes the bridge carrying Southover-road over the railway will be reconstructed and lengthened, and a portion of Lewes Tunnel is being widened to permit the running of stock 9ft. wide. A new locomotive depôt at Norwood Junction has been provided.

Water-softening plants have been or are being erected at Hither Green, Stewarts-lane, Guildford, Norwood Junction, Ramsgate, and Ewer-street. Carriage-washing machines are being installed at Stewarts-lane, Clapham Junction, Selhurst, Orpington, and Slades Green.

**London Passenger Transport Board.**

The reconstructed station at Knightsbridge was opened on February 18th, and that at Chancery-lane on June 24th. Queensbury Station on the Stanmore branch was brought into use on December 16th.

There are three separate stations at Moorgate. The booking-hall of that now known as the City Line —the former City and South London—is to serve for all three railways by means of escalators and subways. Leicester-square Station is being rebuilt in order to combine the Piccadilly and Euston–Hampstead lines under one roof.

---

IN a new heat treatment furnace by Asea-Bofors, the electric heating elements are so designed and fitted that they can be replaced while the furnace is actually in operation. There are two elements, each of which is provided with automatic regulators for the temperature, which can be adjusted to suit whatever material is passing through the furnace.

# THE ENGLISH ELECTRIC COMPANY'S METER FACTORY AT STAFFORD

(For description see opposite page.)

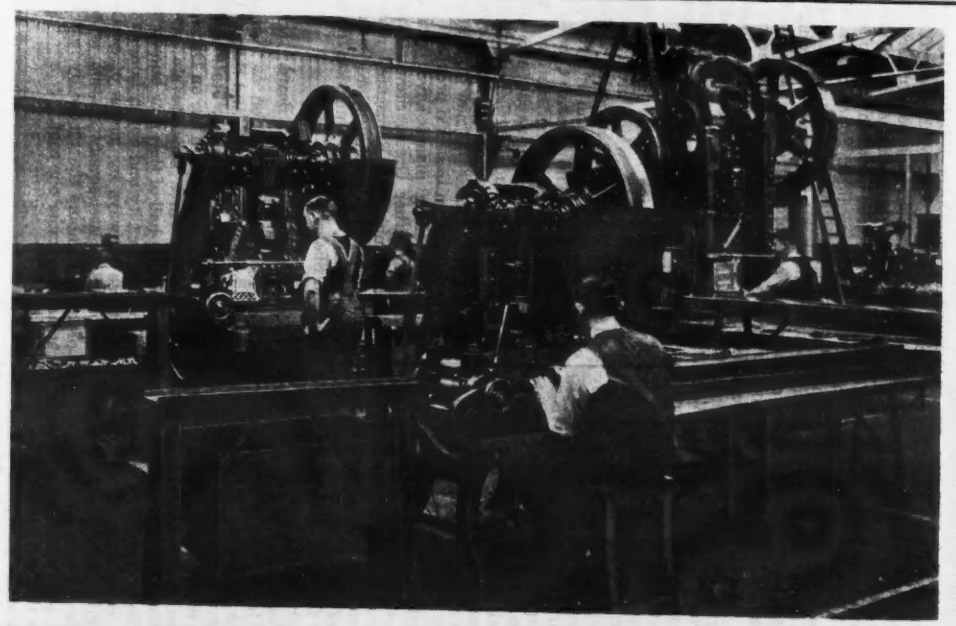


FIG. 1 (ABOVE):—POWER PRESSES

FIG. 2 (BELOW):—ASSEMBLY SHOP

FIG. 3 (ABOVE):—MACHINE SHOP

FIG. 4 (BELOW):—PACKING AND DESPATCH DEPARTMENT

# A New Electricity Meter Factory.

TO the extensive and varied range of electrical work carried out by the English Electric Company at Stafford, that of manufacturing house service meters has been added. An excellently equipped, clean and airy factory, with all the departments on the same floor level, and with every conceivable facility for promoting good working conditions, has been provided on the Stafford works estate. Designed solely for the specialised production of induction watt hour meters of good finish and performance, the factory reflects great credit on those responsible for its lay-out, which affords ready contact of the design, engineering, production, inspection, and testing departments.

Production departments consist of a goods receiving and inspection section, large and small press shops, large and small machine shops, and component and main assembly lines, together with a separate section devoted to finishing processes, such as sand blasting, cleaning, enamelling, and plating. Some of these departments are shown on page 78, while Figs. 5 to 9 show testing and magnetising departments. Before acceptance, all raw materials are subjected to the closest scrutiny by a material expert, after which they are transferred to bins for use in the factory as required. In the large machine shop, equipped with modern presses (Fig. 3), all stamping, drawing, and piercing work is done. All the press tools were manufactured at the Stafford works. A battery of small presses in the small press shop serves for the production of components, such as brackets, plates, &c., and, like the heavier presses shown on page 78, all of these machines have their own motors and control gear. Most of the presses have high-speed feeding and discharging arrangements.

Separated from the main shop by a glazed partition, which facilitates supervision and provides additional light, the large machine shop contains automatic precision capstans, screw-cutting machines, millers, gear and pinion cutters, multi-spindle drilling and tapping machines. Associated with the department is a fine collection of high-speed automatic machining jigs. Inspection work is carried out on very thorough lines. Precision gauges are used extensively, while the quality of the output from gear cutters is constantly checked by optical methods.

Watch capstan lathes of special design for finishing pivots, worms, jewel mountings, &c., are to be found in the small machine shop, in which there are many highly skilled girls. Here, again, precision checking gauges are employed extensively, for the precision required is of a very high order. Each of the lathes is mounted on a polished oak bench, together with a fractional horse-power motor running in conjunction with an industrial sewing machine clutch, both manufactured by the company, whose success at the training of operators is demonstrated by the rapid and effortless manner in which they produce the parts.

Both the components and main assembly sections are laid out to ensure the rapid and easy flow of work down the line. Rotary storage tables between each pair of benches provide a ready supply of parts to succeeding operators, and a small reserve supply in the event of an operator being temporarily absent or if for any other reason the work is interrupted. Routine inspection, by means of checking gauges at the source of production, is carried out at every operation, to enable the product to be kept within the requisite fine limits; whilst in the microscope room (Fig. 8), equipped with wide field binoculars, every jewel is inspected, both before and after mounting, to ensure a perfect bearing, the final cleaning of each jewel being done while under the microscope. Special pre-focussed jigs on the microscope stage facilitate the rapid viewing of the whole object. Here also the inspection of all ball bearings is made and a pre-focussed jig, for which a patent is being sought, ensures that every portion of the ball surface passes across the field, thus enabling the operator to detect the slightest flaw or irregularity. In the same department there is a machine for burnishing the balls, which, after treatment, are checked from time to time by the microscope operators.

A contour projector (Fig. 9) associated with the inspection department is used with various degrees of magnification between 10 and 200 for checking by means of templates the profiles of gear and pinion teeth. As preassembly inspection is of a very thorough character, it rarely happens that errors are found during the process of final inspection, which is, nevertheless, carried out very rigorously.

At this stage the meter brake magnets, which are purchased and not made in the factory, are fitted as received at the assembly benches. The magnets are of uniform strength, and the method of processing them is claimed to be both unusual and exceptionally accurate. After they have been assembled in their support they are magnetised by an automatic surge transformer, when the remanence value is determined on a Neon stroboscopic checking unit operated from a frequency-controlled supply and giving a damping strength to within 1 per cent. Damping strengths of all magnets must fall within a narrow band, otherwise they are rejected. All magnets that pass the test are subjected to several heat-ageing cycles, when the damping strength is again measured on the Neon stroboscopic unit, to ensure that all damping strengths still fall within a narrow band. Magnets that have passed this test are then reduced to almost working strength in an A.C. field produced in apparatus which gives a continuous visible record of the magnet weakening throughout the process. After the magnets have been stored for several months, they are withdrawn from stock for reduction to the working strength, the fall in damping strength from the original value, owing to natural ageing, being noted. By checking the magnets in this way at every stage of the process, the operators ensure that none but perfect magnets find their way to the meter assembly.

Parts of a meter are shown in Fig. 10, in which A is the case from which the meter element has been removed, B the meter frame, C the brake magnet, D a front view of the meter with the cover removed, E a back view of the meter element, F the lower bearing parts, and G the register.

During a visit to the works last week examples of prepayment meters were on view, and we understand that meters of this type will be ready for the market in the near future. Both classes of meter will shortly be available with an all-insulated case.

When a completely assembled meter has passed the final inspection, the windings are tested at 2000 volts for one minute, and immediately after this test the insulation resistance is checked at 500 volts D.C. Both these operations are carried out in a glazed box with interlocked doors, which cannot be opened while the equipment is "alive." All meters are then bank tested on a special board (Fig. 6), supplied with power through split winding transformers, a test which proves whether each meter is sound, and whether it has been fitted with the correct counter ratio. During this test the meters which have not been calibrated at this stage must run to within 2 per cent., and the fact that very few meters fail to meet the requirements of the test is a tribute to the accuracy of the component parts and of the magnet strength. Finally, each meter is calibrated individually on a stroboscopic calibrating unit, against a precision rotating standard

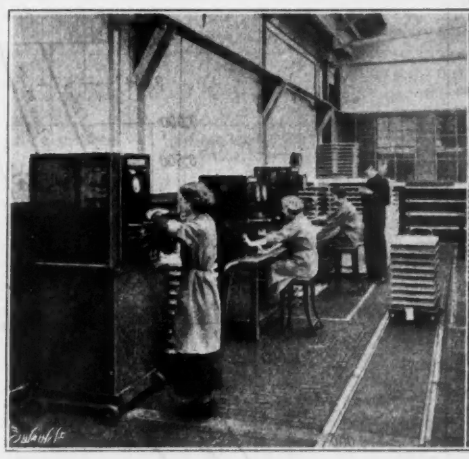


FIG. 5—MAGNETISING DEPARTMENT

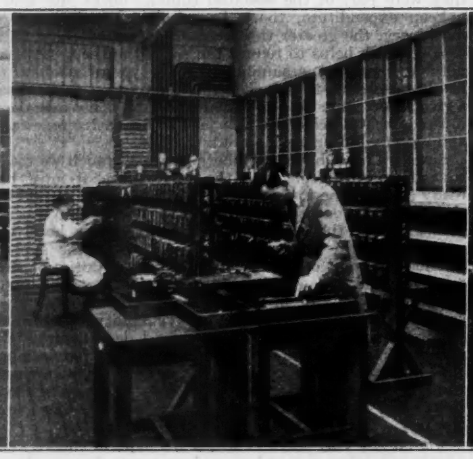


FIG. 6—BANK TESTING DEPARTMENT

FIG. 7—STROBOSCOPE CALIBRATING DEPARTMENT

FIG. 8—MICROSCOPE ROOM

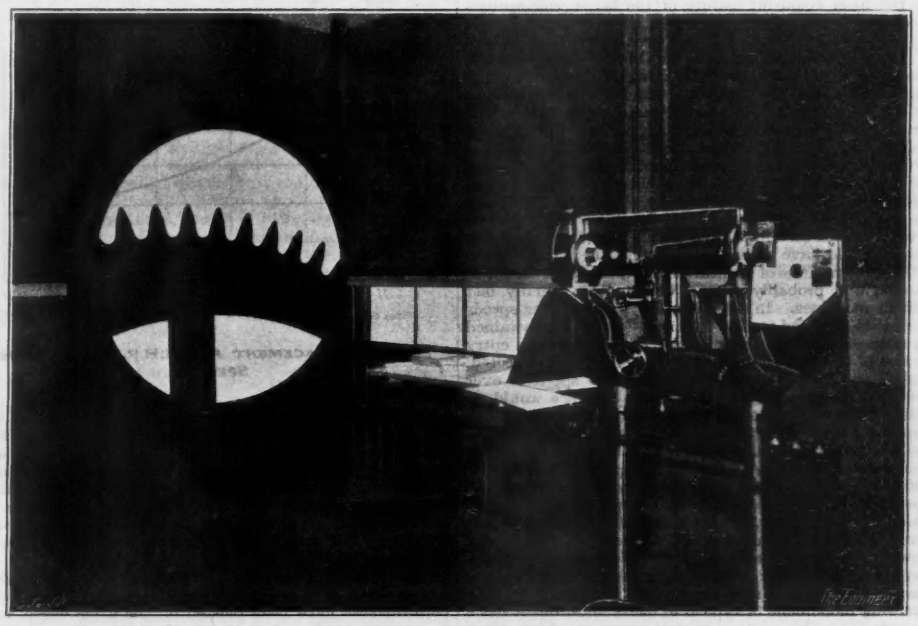


FIG. 9—CONTOUR PROJECTION ROOM

the accuracy being checked at various loads up to 300 per cent. normal at various power factors. Even at this high overload the margin of error allowed is under 1 per cent. As stroboscopic testing has proved to be the most rapid and accurate method available, all meter discs have 400 notches to permit of its adoption. The performance of each meter is checked on 5 per cent. load and a 50 per cent. over voltage is applied at no load to check freedom from creeping, whilst as a final test all meters are banked

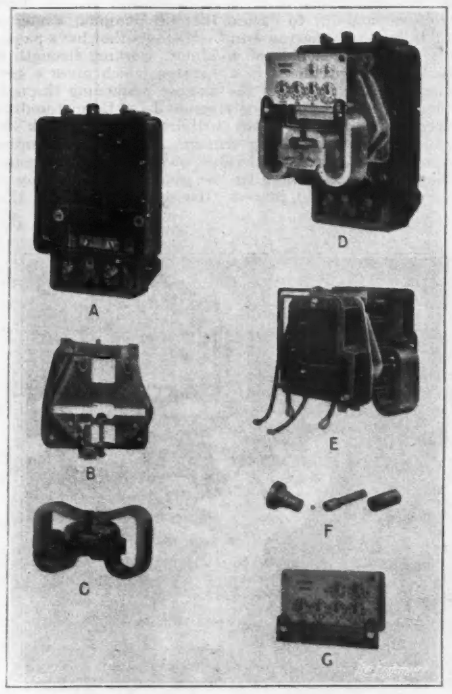



FIG. 10—METER PARTS

and run for several hours at various loads as a check on counter friction and general operation.

For dealing with special investigations there are standardising and research laboratories, and chemical and metallurgical laboratories. All the testing apparatus including stroboscopes, transformers, machines, and control gear were designed and manufactured in the company's works, an achievement which indicates ability of no mean order on the part of the company's staff.

## AN ENGLAND—SOUTH AFRICA AIR RACE.

PLANS are being considered for a spectacular air race from Britain to South Africa and back, on the lines of the MacRobertson race to Australia. The race would be the most colourful feature of the lavish celebrations next May, both of the twenty-fifth anniversary of the Union of South Africa and the twenty-fifth anniversary of King George's accession to the throne. The proposed route would be about 14,000 miles, and the general scheme suggested is that the competing machines might leave a British aerodrome at dawn on Wednesday, May 29th. The outward course would be through Cairo, Nairobi, and Johannesburg to Cape Town. After spending a day or two at Cape Town the planes competing would start again for England by any route they chose. Probably some pilots would take the opportunity of making an attack on the Cape-Croydon record by flying an almost direct course. It is certain that a number of the competing planes would have speeds in excess of 200 m.p.h., as the "Comet" machine of Cathcart Jones and Waller would be entered and probably other "Comets," or equally fast British machines. In all probability, too, higher speeds than that credited to the "Comets" would be attained by some of the competing planes. For instance, an entry or two of German Junkers monoplanes is to be expected, and these machines are known to have a speed of over 210 m.p.h. and those constructed for the race would no doubt have a speed much in excess of that. The large Junkers planes recently bought by the Union Government have astonished the people in all the centres of the Union so far visited, not only by their speed, which touches 200 m.p.h., but by the elaborate safety arrangements and the comfortable quarters for passengers. The Junkers six-seater monoplane, which the Union Government is going to put into commission on the new route from Cape Town to Windhoek, as soon as South-West African Airways have been taken over by the Government, will have a yet greater speed. The machine is the "Ju. 160," and is a low-wing monoplane of typical Junkers lines, but it has a smooth "skin" in contrast with the corrugated iron effect of the other Junkers machines. There is a retractable undercarriage and the engine is a B.M.W. "Hornet" of 700 h.p.—three times the power of the motors used in the D.H. "Comet" with which Scott won the air race from Britain to Melbourne. The machine has a loaded weight of 7825 lb., but her disposable load is only 2535 lb. This means that the pay load is small in comparison with the weight of the machine. Economy is really sacrificed for speed. The plane is capable of over 210 m.p.h.

THE old Pelaw shipyard on the Tyne, which has been idle for some years, has been purchased by a local syndicate, who will, it is stated, develop and reopen the yard for industrial purposes.

# Marine Engines by a Superintendent.*

By STERRY B. FREEMAN.

FROM the economic standpoint, the provision of machinery in a ship is a regrettable necessity. It occupies valuable space, usually in the most commodious part of the ship, machinery casings interfere with the deck spaces, and, generally speaking, the less room the engine and its fuel occupy, the better for the economic return. The superintendent has to restrict the space which the machinery occupies, both in length and height, and also cut down the weight as far as may be prudent, always remembering that transport of cargo is provided for the convenience of shippers, not for the edification of engineers. Every refinement introduced into the engines has to be paid for, both on its installation and for its maintenance; the provision of stand-by and emergency plant has also to be carefully considered, and it may be necessary to do without many tempting details, which cost as much as though they were part of the essential running outfit and need upkeep expenditure, too. As a rule, the plainer the machinery, the greater the accessibility for overhaul and repair, which helps to reduce the cost of upkeep. It is a notable point that, assuming the right type of machinery has been selected to suit the conditions, sound design has a great effect upon the cost of running, for it is not mistakes in fundamental principles that lead to expensive renewals and repairs, but errors in detail.

Since we must have machinery, however much we may restrict its infringement on the cargo space, it must be ready at any time to face the worst that nature can do in the matter of weather. The soul of the sailing ship was in her sails, but the soul of the modern floating hotel or warehouse is in the engine-room, and from the superintendent's point of view, the interests and duties of the surveyor and his own are identical, in that the first requirement of any marine equipment is safety. The cardinal virtue in a marine engine is reliability. The three factors ensuring this quality are sound design, material, and workmanship, and the superintendent envisaging the building of new marine engines, or keeping old engines running in service, has to learn and apply all he can of good practice in these three essentials to ensure freedom from trouble.

One of the easy ways in which the superintendent can obtain reliability is to adopt a twin-screw design. It is rarely the case that both engines will fail at the same time. Considerations of space and weight and of additional staff come in, and may rule the twin screw out of court. The installation of a high-pressure and a low-pressure turbine, or two oil engines, each driving a pinion shaft on a common gear wheel and one line of shafting, is a half-way house between the twin and the single-screw ship. Some long passages have been made on either H.P. or L.P. turbine, after the other section of the turbine or its pinion has failed. Both the reciprocating steam engine and the heavy oil engine can, of course, run with less than their full complement of cylinders, and one of our oil engines has come home from Australia running perfectly well and steadily, and at full power, with one of its eight cylinders cut out the whole way.

In the design of the modern ship, speed has its place. The speed required of the ship has an effect on the design of suitable engines, and it is remarkable how rapidly the horse-power required increases with the speed. The curve, Fig. 1, shows the displacement tons propelled per s.h.p. for a range of speeds from 11 to 16 knots. As the fuel

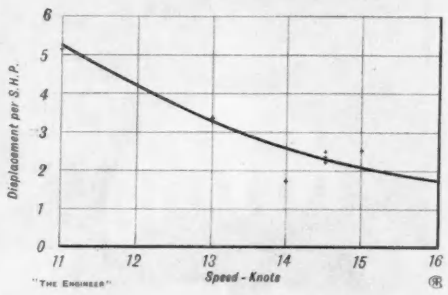



FIG. 1—DISPLACEMENT PER S.H.P. AT VARIOUS SPEEDS

consumption per s.h.p. is approximately constant for any engine type, this curve is also representative of the tons carried per £1 expended on fuel. It will be seen that the present trend of high speeds is expensive, and is not suitable for the carriage of cargo on which only small freights are earned. It is for this reason that many of the high-speed cargo vessels make many voyages at comparatively low speeds, and only use their full power when required.

Fig. 2 shows actual tank results for a motor ship with a maximum service speed of 16 knots. Actual voyage performances have been plotted on the same curve, and these serve to show how closely the tank tests approach the actual performance of the completed vessel and also the rapid advance of power with the speed.

This demand for additional speed and increased economy of operation has led to the employment of types of machinery, systems, and methods which previously would have been felt unduly risky. At the same time, the trend is towards simplicity, so far as the accepted types of turbine and oil engine are concerned. The addition to the reciprocating engine of efficient valves and an exhaust turbine cannot better the performance of the turbine, and may increase the cost of upkeep. For the highest powers, the right choice is still the turbine, working, of course, with superheated steam at high pressure. The statistical returns of the Society show the advance the oil engine is making, especially for moderate power installations, and that oil fuel burnt in the engine or in the furnace is a necessity for the large passenger ship.

From physical considerations, it may be possible to prove that 9 or 10 knots is the most economical speed to move general cargoes about the world. The higher the speed of the ship, the smaller the carrying capacity, due to the finer lines of the hull, increased bunker spaces, and greater weight of machinery. But the shipper wants payment for his goods as early as possible, values may fluctuate while the cargo is afloat, the sooner freight is earned the sooner the vessel is released to earn fresh freight, possibly at higher rates, running costs go on, wages, victualling and insurance mount up, and, beyond all these, there is a satisfaction in "getting on," which we all recognise. A vessel known to be slow is shunned and a faster ship favoured. Passengers are even more swayed by speed. It was predicted, when wireless telegraphy came into use at sea, that faster ships would not be found necessary, since one could keep in close touch with affairs, the markets, &c., and carry on one's business as though in an office ashore. This has not yet been the case, as is obvious by the building of recent high-speed liners. A more significant omen is now observed in the

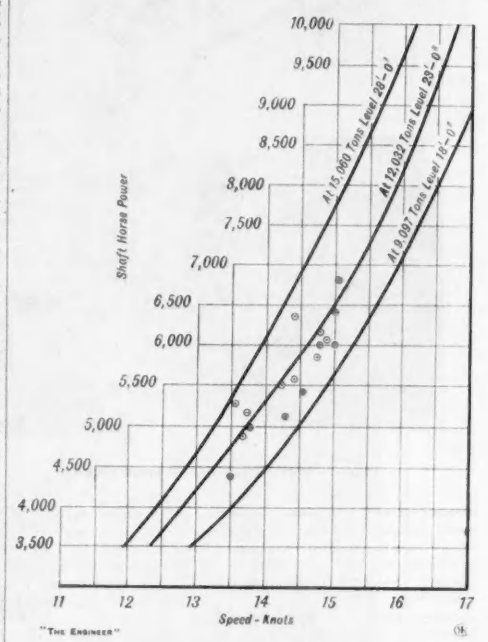



FIG. 2—CURVES OF S.H.P. FOR MOTOR SHIP

scheduling of passages to far parts of the world by air, which service, if developed successfully, may lessen the demand for the fast passenger ship.

The engineer is required, by the pressure of circumstances, to design for more and more power from less and less space and weight, so that the higher speed may be obtained from engines which are no larger and no heavier, and consume relatively no more fuel.

There is, of course, a great difference between the most efficient and economical propelling plant to suit the requirements of a fast passenger liner, a cargo liner, a tramp, and a coaster. The conditions of an Atlantic passenger liner, where high powers and absence of noise and vibration are first essentials, where there is no great restriction on weight of machinery, where, although headroom is restricted, there is ample room fore and aft at the bottom of the ship for bunkers and machinery, and where oil is dear but essential, and coal cheap but impracticable, are very different from those obtaining in a cargo liner trading to the Far East. Here speed is comparatively low, vibration and noise are not a bugbear, ships load to their full capacity, both as regards space and deadweight, oil is cheap and coal frequently dear. In addition to the differences of atmospheric, engine-room and sea temperatures, there are draught limitations, loading conditions and weather differences between an eastern and a western voyage to be considered.

The tramp and the coaster as a rule are compelled to adopt the simplest type of machinery, as the questions of first cost and of *personnel* come in, but, as you know, there is a trend in these fields also towards the more complicated but more efficient plant.

As racing men say, "horses for courses," and the superintendent falls back on the only safe plan of putting down the details on paper and working out the returns on the different proposals possible.

A few years ago the oil engine would not have been considered as reliable as the steam engine. To-day, apart from experimental designs, there is little to choose between the two, although the conservative instincts of some of us cause us to cling to the idea that the old massive, slow-running, open-fronted, main engine, supplied with saturated steam from Scotch boilers, is the acme of reliability. The need for economy in fuel and in space and weight has brought the light, fast-running, forced-lubricated type of engine supplied with superheated steam from water-tube boilers to the forefront. The work of the turbine designer, the gear cutter, and the metallurgist have made this new conception of the marine steam engine an equally reliable alternative. As has been pointed out elsewhere, the high thermal and overall efficiency of the oil engine has spurred on developments in the steam engine and steam boiler, giving the shipowner a wide choice as to his prime mover.

The steam engine is greatly helped in competition with the oil engine by the recent developments in the water-tube boiler, which we are all watching with interest. The present position is that the turbines plus Johnson boilers, as in "Asturias," occupy no more space than

* Lloyd's Register Staff Association, January 10th, 1935.

the old four-stroke cycle, double-acting oil engines which they replace, develop more power, and are of less weight. In either case the only fuel at present practicable is oil. The consumption of oil per s.h.p. hour is, in the case of the turbine installation, approximately 0·6 lb. per hour, and in the case of the oil engine approximately 0·4 lb. per hour. These figures may be shaded off to, say, 0·57 lb. and 0·365 lb. in certain cases, but the general consideration remains that 50 per cent. more fuel must be carried in the case of the turbine than in the oil-engined ship. The oil for the oil engine will be more expensive than that for the water-tube boilers, and that cost must be set against the provision of the necessary bunker space and the possible shutting out of cargo. We are now promised still further developments of the steam producer; the Benson boiler, after prolonged trials in "Uckermark," is being fitted in more mercantile ships, the Velox boiler promising rates of evaporation about five times as great as in present practice, the Loeffler boiler evaporating water by superheated steam, and the Sulzer single-tube boiler. It would be pleasant and popular if one could record that these new steam producers opened up a field for the use of our coal again, but they do not. It may be they can utilise powdered coal in some form, but then the question of transport of the necessary quantity of bunkers comes in once more, and the other handicaps under which coal labours: space, handling, dust and dirt, ashes, corrosion of bunkers and steel work, delay in bunkering, loss of steam while cleaning fires, and so on.

When considering the oil engine, the possibility of further economies is not so apparent. It has been obvious for some years now that the goal towards which oil engine designers must work from the original four-stroke cycle single-acting engine with blast air injection of fuel was the two-stroke cycle double-acting engine with airless injection of fuel and the exhaust gas boiler. This has now arrived, but there has been little alteration in the rate of fuel consumption. There is a tendency to increase the maximum pressures, which results in a reduction of fuel consumption. The earlier engines operated at about 500 lb. per square inch maximum pressure, the later airless injection engines at about 850 lb. per square inch.

The general conditions under which the propelling machinery of various types will operate are set out below:

| | Coal. | Oil. |
|---|---|---|
| Fuel values— | | |
| Available heat in fuel, B.Th.U. per lb. | 15,000 | 19,000 |
| Probable average value, B.Th.U. per lb. | 12,500 | 18,000 |
| Boiler efficiency— | | |
| Cylindrical boilers, per cent. | 65–75 | 77–82 |
| Water-tube boilers, per cent. | 75–80 | 85–88 |
| Mechanical efficiency of engines— | | |
| Reciprocating steam, per cent. | 90 approximately | |
| Oil engines, depending upon type, per cent. | 72–88 | |
| Overall thermal efficiency— | | |
| Reciprocating engines using saturated steam, per cent. | 11 | |
| Reciprocating engines using superheated steam, per cent. | 13·5 | |
| Reciprocating engines and exhaust turbines using superheated steam, per cent. | 16 | |
| Turbines and gearing working at low pressures and temperatures, per cent. | 16 | |
| Turbines and gearing working at high pressures and temperatures and using oil engine-driven generators for auxiliary power, per cent. | 24–27 | |
| Oil engines with air injection of fuel, per cent. | 35 | |
| Oil engines with airless injection of fuel and high maximum pressure, per cent. | 40 | |
| Oil engines with waste heat boiler, per cent. | 37 | |
| Oil engines with heat recovery on Still system,* per cent. | 43 | |

* See Professor C. J. Hawkes's Thomas Lowe Gray Lecture, "Proc.," I. Mech. E., 1928, Vol. i, page 6.

The relative fuel consumption can be obtained from these values.

It will be evident that in the case of the tramp and the coaster the comparison will lie between the low-pressure boiler and steam reciprocating machinery, probably using saturated steam, and the simpler forms of single-acting oil engines, plus waste heat boiler. The former plant is of much less economy than the latest steam engines and boilers, whereas the latter plant will be nearly as economical as the latest types of oil engines.

To obtain a straight comparison of the two types of machinery, steam and oil, 8000 s.h.p. has been taken as a basis. That is a power which can conveniently and economically be developed in either a steam or an oil engine. The oil engine of this power would be of the two-stroke cycle double-acting type if built as a single-screw unit.

Table I gives a comparison of the running costs of different types of machinery of this same 8000 s.h.p., where the ratio of first cost, rate of fuel consumption and the details of running cost have been taken from actual experience.

Several builders of steam reciprocating and steam turbine and oil engines have been good enough to give me figures for the ratio of cost between the different types of machinery for the same h.p. under discussion, and these are tabulated.

TABLE I.—*Comparison of Running Costs of Oil Engines and High-pressure Turbine Machinery of 8000 s.h.p.*

| Proposal. | Oil engines. | | | High-pressure turbines. | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | A | B | C |
| Type of machinery | 4-stroke, single-acting, super-twin screw | 2-stroke, double-acting, twin-screw | 2-stroke, double-acting, single screw | Coal-fired boilers, twin screw, mechanical stokers | Oil-fired boilers, twin screw | Oil-fired boilers, twin screw, electrical auxiliaries |
| Ratio of machinery costs | 123 | 117 | 113 | 101 | 100 | 110 |
| Fuel per s.h.p.-hour, lb. | 0·40 | 0·40 | 0·40 | 1·00 | 0·71 | 0·60 |
| Fuel per day, tons | 34·5 | 34·5 | 34·5 | 86 | 61 | 51·5 |
| Running cost per annum, including:— Fuel, Stores, Repairs, Wages, Victualling, 4 per cent. depreciation | £29,600 | £29,400 | £28,600 | £36,700 | £39,000 | £31,700 |

| Summary of costs. | 1 | 2 | 3 |
|---|---|---|---|
| Saving per annum compared with A | £7,100 | £7,300 | £8,100 |
| Saving per annum compared with B | £9,400 | £9,600 | £10,400 |
| Saving per annum compared with C | £2,100 | £2,300 | £3,100 |

TABLE II.—*Comparison of Prices for Various Types of Propelling Machinery of About 8000 S.H.P.*

| | A. | B. | C. | D. | Range of prices. |
|---|---|---|---|---|---|
| Steam reciprocating | 1·0 | 1·0 (0·985 if W.T. boilers) | 1·0 (twin-screw) | 1·0 | 0·985–1·0 |
| Steam reciprocating with Bauer Wach turbines | 1·13 | — | — | — | 1·13 |
| Geared turbines | 1·27–1·33 | 1·142 | 0·97 (single-screw) | 1·3 | 1·142–1·33 (0·97 if single screw) |
| Turbo-electric | 1·47 | 1·44 | 1·06 (single screw) | 1·4 | 1·4–1·47 (1·06 if single screw) |
| Oil engines | 1·33 | 1·35 | 1·34 (twin screw) | 1·47 | 1·33–1·47 |
| Oil engines, electric transmission | 1·66 | 1·69 | — | 2·1 | 1·66–2·1 |

The prices refer to the particular types of vessels built by the respective shipbuilders; it should not be assumed that they refer to competitive prices quoted for the same vessels by the various builders.

Dealing with the items included in the running cost per annum, it will be understood that the cost of fuel is not made public by shipowners, but it is safe to say that some such ratio as coal 1, boiler oil fuel 1·75, engine oil fuel 2·15, would not be very wide of the mark.

The cost of repairs in our experience does not vary much between ship and ship, age having more to do with the amount of repair than the type of machinery. You surveyors will, I think, bear me out in saying that in modern machinery of those types which have been accepted as standard, there is little repair to be done beyond the normal renewal of wearing parts.

Stores include all that is used in the running of the engines except the fuel. Generally, it is the cost of the lubricating oil which increases the cost of the stores for the motor vessels.

The wage bills for the engine-room complement for the various types of machinery do not vary much, except, of course, for twin and single-screw machinery. In motor ships where firemen are not required, the saving is wiped out by the cost of the necessary electricians and extra cleaners.

The cost of victualling is dependent upon the crew carried, and, again, there is not the difference one might expect.

The depreciation of the machinery and hull is a difficult matter to decide. Some owners build a ship to run 25–30 years, whereas others prefer to sell them when only fifteen years old. Each case must, therefore, be decided on its merits.

In the above tables steam reciprocating engines have Scotch boilers working at 220 lb. per square inch unless otherwise stated. Geared turbines and turbo-electric have water-tube boilers working at 400 lb. per square inch. It will be noticed that there is not so great a difference in the cost of steam turbines and oil engines as might be imagined.

The matter of repairs and renewals is extremely important, both from a cost and a reliability point of view.

It is interesting to compare the cost of repairs for the various types of vessels, but rather difficult to obtain a good idea of these in a fleet of vessels which is kept up to date. In such fleets, the steam reciprocating engines, steam turbines and motor vessels were generally added at different times, *e.g.*, steam reciprocating engines prior to 1922; turbines from 1920 to 1925 and since then oil engines. There are sure to be exceptions to this, as many firms have distinct preferences for particular types of machinery, but the above dates give an idea of what happened in many cases.

It is thus difficult to give correct ideas of the relative costs of upkeep as there may be ten or more years' difference in the ages of the types of engines under comparison which makes a big difference in repair bills. Also, the oil engines built in 1924 are liable to be more expensive in upkeep than modern machinery, but this is not always so, as the earlier engines were more lightly rated and, consequently, breakdowns due to heat stresses fewer.

To deal effectively and economically with repairs it is of great value to have reliable and adequate records of wear. In addition to the wear down gauges supplied for the turbine main bearings and the reciprocating engine crank shaft, records should be kept of the wear down of the tunnel shafting. The gauging of the distance between the inner faces of the crank webs as the shaft is revolved in its bearings is another useful method of detecting abnormal wear. This method of testing for alignment has been found especially useful in the case of crank shafts driving heavy generators with a common main bearing for crank shaft and generator on the inner side; a typical set of readings is shown in Table III. Boiler defects and cracks and oil engine cylinder head cracks should be noted, and any extensions kept under observation. It is found that while records of oil engine cylinder liner wear are always taken and studied in the case of main propelling units, they are not always so closely kept up in the case of main engine steam cylinders and of auxiliary machinery as they should be. Typical records are shown in the original paper.

In the case of turbine ships, such details as blade clearances, bridge gauge readings of rotors, pinions, and gear wheel shafts are of real importance. Typical record sheets for these accompany the original paper.

Records of propeller and propeller shaft damage are most necessary, and it is surprising to find the amount of small damage to propellers that takes place. Such records show that in a fleet of 80 ships, 207 accidents occurred to propellers in twenty years. Of these 111 were in respect of single-screw ships, and 89, or 43 per cent. of the total, twin-screw ships.

For years very detailed records were kept of the condenser tube failures showing the type of failure, position in condenser and in tube, and so on. It is a matter of thankfulness that the introduction of reliable tubes has made it unnecessary to maintain these records.

Each ship has a large data book in which is kept the particulars of the main and auxiliary machinery, the spare gear, the records of dry docking, surveys held, examinations of machinery, principal renewals and repairs, and the above records of measurements, so that the past history of the plant can be immediately traced on the ship. The vessel's final summary of log for each voyage is also entered in this book, so that the chief engineer may know what has been done on previous voyages. This book is kept in duplicate, one copy on board and one in the superintendent's office, and the copies are exchanged at the end of each voyage so that the superintendent also has a copy of the ship's history before him.

Careful records are also kept of the cost of repairs and stores to the various ships, and Table IV gives the ratio of costs for supplying stores and carrying out the necessary repairs to the engines and auxiliaries for various machinery types.

The superintendent will often be asked what is the economical speed for a ship, and the answer is on these lines. When a ship is on a definite run for long periods, the economical speed will be given by taking into consideration all the running expenses, wages, victualling, fuel, repairs, stores, &c., and depreciation, and finding the speed at which the cost of these is at a minimum.

If ship is to go at her most economical speed because of bad trade, then the factor of depreciation in the comparison should be omitted, as the ship presumably could not earn more freight, even if the speed were increased and more voyages made.

In some companies, the wages of crew are paid whether ship is at sea or not. When this is done the wages will be omitted in working out the most economical speed for bad trade conditions.

Before deciding upon the economical speed at which to send a vessel on her voyage, it is necessary to know which of the above three cases is applicable.

It should be remembered, however, that the economical speed of a vessel may not be a satisfactory one from the point of view of obtaining the proper share of cargo, passengers, &c.; in fact, it may be generally stated that the present-day conditions demand that the cargo liners run at speeds greatly in excess of their economical speed.

After the engine type has been decided, the next important consideration is the material of which the component parts will be constructed. The higher stresses and temperatures under which modern machinery is operated

TABLE III.—*Vessel "Aeneas." Port Liverpool. Date August, 1934. Record of Gaugings Between Webs of Main Engine Crank Shaft.*

| Position of crank. | Port engine. | | | Starboard engine. | | |
|---|---|---|---|---|---|---|
| | H.P. | M.P. | L.P. | H.P. | M.P. | L.P. |
| Top centre | 0·261 | 0·262 | 0·275 | 0·272 | 0·245 | 0·229 |
| Diff. top and bottom centre | 0·005 | 0·004 | 0·004 | 0·001 | 0·002 | 0·009 |
| Bottom centre | 0·266 | 0·258 | 0·279 | 0·271 | 0·247 | 0·238 |
| Starboard centre | 0·264 | 0·264 | 0·280 | 0·273 | 0·247 | 0·237 |
| Port centre | 0·263 | 0·258 | 0·272 | 0·272 | 0·244 | 0·232 |

Gaugings are in excess of 14in. width between webs and are expressed in thousandths of an inch.

has called for alloyed steels, both in forgings and castings, pearlitic cast iron, and a whole range of improvements in the non-ferrous metals. You will have had experience of these in the test house, and in the works, and have seen the results after running under working conditions. The improvements in the manufacture of forged steel have helped the turbine builder, the production of alloyed steel has given confidence in the use of gearing, tank marine boilers are built with high-tensile shells for high pressures, the drums for water-tube boilers are pressed out of solid ingot in amazing presses, and the tubes are equally beautifully produced in such alloys as Dr. Dorey has so well described in his paper on boiler tubes, delivered to the Institute of Marine Engineers in 1930.

As regards the cast iron required for the higher temperatures involved in superheating and in oil engine use, the metallurgist came in here to help the superintendent, and we have now no hesitation in subjecting cast iron to temperatures at one time thought to be dangerously high.

It was discovered that a low silicon cast iron could be produced in which the carbon content was so finely divided that the splitting action of carbon flakes did not break up the iron. Further research and invention showed the foundrymen how regularly to produce pearlitic cast iron. These cast irons have been tried in those difficult conditions under which the two-stroke cycle oil engines work, and, as a rule, are satisfactory, but in cases it has been found necessary to replace them by special chrome cast steel.

One of the most beneficent discoveries has been that relating to condenser tube material. After the war the marine world had an epidemic of condenseritis. Condenser tubes have had a way of failing in cycles, and in 1920–24 we had a visitation. Owners found themselves faced with heavy bills for renewals of tubes. Engine builders were asked to pay claims for defective material and workmanship in these tubes. The Navy and the high-speed liner fled for safety to the expensive cupro-nickel tube. The discovery by the Corrosion Research Committee of the Institute of Metals of the aluminium-brass tube (copper 76, zinc 22, aluminium 2, instead of the old copper 70, zinc 30) has solved the problem of an efficient and cheap condenser tube. The use of this tube has had a most marked effect upon the practice of superheating. Superintendents found that those plants which had leaky condenser tubes developed leaky or blocked superheater tubes. The salt water from the circulating side of the condenser passing to the steam side caused priming in the boilers, so that scum and dirt were carried over into the superheater tubes, was baked in them, and soon the tube failed. The erosion and pitting of turbine blades, the wear of reciprocating engine piston-rings and metallic packings have all been reduced since condenser tubes have been put right.

In the earlier days some anxiety was caused by turbine blade failure, but the use of manganese copper blades, steel blades, or chromium iron blades has dissipated that care, and we rarely hear of troubles in this connection. Surveyors can help enormously by their supervision of material and workmanship. If these are originally good, the life of the plant is greatly increased and expense lessened.

In dealing with the steam engine, it is curious how superheating of the steam in marine practice lagged behind land practice, but it is an essential feature in marine practice to-day.

The maximum temperature at which the materials at present available for superheaters and turbines can be used—at any rate, for marine work—is about 750 deg. Fah.

The efficiency of steam engines cannot be raised to any large extent so far as we can see at present, owing to the limitation of temperature by the materials in use. Competition is so keen, however, between the steam and oil engines that it is unsafe to predict that further improvement is impossible or far off.

At one time the advocates of the oil engine could point to the gearing of the turbine ship as being a weak spot. I should take space here to say that gearing is now as reliable as any other part of the equipment. Our first gears were designed with a load of 1000 lb. per lineal inch of gear face, and that gearing is running well to-day. But before that ship had gone to sea, such troubles had been found elsewhere that a halt was called and the loading on the next gear teeth was reduced to 600 lb. It was not until about 1923 that the cause of the mischief was found to be in defective gear cutting, originating in a cumulative pitch error in the master wheels of the gear-cutting machinery. Since gear-cutting practice has been tightened up, that source of worry has been largely removed.

In the oil engine the principal troubles for all makes of engine have been the cracking of cylinder heads, liners, and pistons, and the deterioration of the oil in the crank case, causing undue wear in the bearings. The remedy for these troubles has been the use of fresh water instead of salt for the cooling of the heads and liners, or, where salt is used, the use of acids to remove scale which is deposited on the heating surfaces. The oil can be kept free from water by the simple expedient of using oil instead of water as the cooling medium for the piston.

Having built and run the most desirable engine, it is, of course, of great importance to know exactly what the performance has been, and the engineer in charge sends home his results, measured as accurately as he finds possible.

The measurement of results is not easy once the machinery has been installed in a ship. The engineer in a power station ashore has space in which he can marshall his coal and ashes, erect tanks to store his water supplies, and deal with his meters, gauges, and other instruments. In a ship, space is of value, and in the majority of cases the trials carried out at the beginning of a vessel's career are the only ones on which money and time are expended to ensure a correct result.

The owner, however, should have some sort of a measuring stick by which to assess the value of his ship's performance relatively to the same ship's previous performances and to those of other ships.

TABLE IV.—*Comparison of Cost of Repairs and Stores for Engines of Various Types.*

| | Age. | S.H.P. | Repairs. | Stores. |
|---|---|---|---|---|
| | Years. | | Per cent. | Per cent. |
| Single-screw reciprocating saturated | 23 | 4000 | 100 | 100 |
| Twin-screw " " | 29 | 5500 | 105 | 110 |
| Single-screw superheated | 20 | 4300 | 105 | 111 |
| Twin-screw " | 28 | 4300 | 125 | 116 |
| " " (passenger ship) | 24 | 5000 | 190 | 165 |
| " " " " | 21 | 6000 | 230 | 175 |
| Single-screw coal-fired turbine | 13 | 6000 | 99 | 112 |
| Twin-screw " " (passenger ship) | 10 | 7500 | 180 | 205 |
| " " " | 13 | 6500 | 195 | 149 |
| Single-screw oil-fired turbine | 13 | 6000 | 75 | 110 |
| " " " | 10 | 3700 | 70 | 95 |
| Twin-screw " " (passenger ship) | 10 | 7500 | 120 | 170 |
| Twin-screw oil Engine | 9 | 3700 | 62 | 160 |
| " " " | 8 | 6000 | 88 | 200 |
| " " " (exhaust gas supercharge) | 4 | 5500 | 55 | 160 |
| " " " (chain-driven supercharge) | 4 | 8600 | 110 | 175 |

For this purpose the Admiralty coefficient and fuel coefficient are very valuable. These formulæ do not take into account the effects of bad weather, bad coal, and difficult conditions, but these figures when compared with those of similar ships or previous voyages of the same ship give a very good idea of the merit of a voyage performance.

Looking back, it is refreshing to note how many of our old troubles have been cured, or at all events lessened, by the advance in technical achievement. The use of electric welding, for example, has made unnecessary those very difficult and often unsatisfactory patches which we surveyors used to plan with the superintendent and the foreman boilermaker, the "putting on tool," for which we used to send the youngest apprentice, has become a reality, and steel, cast iron, and even brass parts are now built up in place, or forgings, such as pinion shafts, are sent to have nickel or other metal deposited upon the worn parts.

After dealing with these details of marine machinery, it is interesting to consider the conditions under which it is to work. Immediately there will spring to the mind of the older generation a picture of the machinery they used to operate, simple, rather ponderous, hand-lubricated, adjusted by rule-of-thumb methods, and entailing much heavy manual labour in overhaul. The men who dealt with this plant were, as a rule, craftsmen rather than technicians, who were concerned with overcoming the deficiencies of the original design, material, and workmanship, as well as with the making good of fair wear and tear.

To-day, the majority of new ships have machinery which is designed to work at higher speeds, temperatures, and stresses, and the young men who are coming forward to take charge of this more complicated and exacting machinery are, on the whole, better equipped technically than their predecessors, although usually less skilful craftsmen. I should like to take this opportunity of bearing testimony to the keenness of the marine engineer. The older men have taken up both turbine and oil engine work with enthusiasm, and have faced the Board of Trade examinations for oil engine endorsements with courage and success—no light task when long past school age. The younger men come to us with creditable records of work done in the shops and in the technical schools, often with National Certificates, and work as well and hard as the boys of my early sea-going days.

It is realised, of course, that this necessarily incomplete and possibly one-sided review of the present position of marine propelling machinery only represents my own view of its trend and possibilities.

British shipping is faced with such extraordinary difficulties at present that any help that can be given by sharing our experiences with our friends should be readily forthcoming. If this lecture is in any way helpful to any of your members, I shall only be repaying a small part of a debt of gratitude which I, like all other engineer superintendents, owe to your great Society.

## THE INSTITUTE OF METALS.

THE Institute of Metals is to hold its annual general meeting in London on Wednesday and Thursday, March 6th and 7th. There will be two morning sessions, as well as an afternoon session on March 6th. In the evening of March 6th the annual dinner and dance will be held at the Trocadero, and in the afternoon of March 7th there will be a visit to the Battersea Power Station. An additional gathering will take place in the evening of Tuesday, March 5th, when a joint meeting will be held with a number of technical institutions to enable members to participate in a discussion of "Problems of Cold Presswork." The discussion will be opened by a paper by Dr. H. J. Gough, F.R.S., Superintendent of the Engineering Department of the National Physical Laboratory, and in the following paper, by Dr. C. H. Desch, F.R.S., Superintendent of the Metallurgy Department of the National Physical Laboratory, there will be summarised the existing information regarding cold pressing from the metallurgist's point of view. This joint meeting, which is being organised in co-operation with the Institution of Automobile Engineers, will be held in the Hall of the Royal Geographical Society, and is expected to be attended by about 500 members of a dozen societies.

*Educational Tour to Germany.*—Following the success of last year's educational tour to Belgium, the Council of the Institute of Metals has now completed plans for an educational tour to Germany for junior members of the Institute, college students, and members of staffs of educational and research institutions. The tour will begin on Saturday, April 6th, the party being due back in London on Monday, April 15th. During the visit, which will be to the Rhineland of Germany, several important works of metallurgical interest—ferrous and non-ferrous—will be inspected. Opportunities will also be afforded to meet German students, as well as to see something of the beauties of the Rhine. The cost of the tour is expected to be approximately £12.

*Annual May Lecture.*—Professor W. L. Bragg, F.R.S., is to deliver the twenty-fifth annual May lecture of the Institute of Metals on Wednesday, May 8th. He has chosen as his subject "The Atomic Arrangement of Metals and Alloys."

*Autumn Meeting in Newcastle-on-Tyne.*—The Institute's twenty-seventh annual autumn meeting will be held in Newcastle-on-Tyne from Monday September 9th, until Thursday, September 12th.

## LAUNCHES AND TRIAL TRIPS.

IMPERIAL STAR, motor vessel; built by Harland and Wolff, Ltd., to the order of the Blue Star Line; dimensions, 516ft. 9in. by 70ft.; to carry cargo and passengers. Diesel engines, Harland-B. and W. type; trial trip, recently.

ANCYLUS, motor vessel (tanker); built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of Anglo-Saxon Petroleum Company, Ltd.; dimensions, 460ft. by 59ft. by 34ft.; to carry oil in bulk. Diesel engines of Hawthorn-Werkspoor type; constructed by R. and W. Hawthorn, Leslie and Co., Ltd. Trial trip, January 7th and 8th, 1935.

AUSTRALIA STAR, motor vessel; built by Harland and Wolff, Ltd.; to the order of Blue Star Line, Ltd.; dimensions, 535·5ft. by 70ft. by 43·3ft.; to carry cargo and passengers. Diesel engines, Harland-B. & W. type; constructed by the builders. Launch, January 8th, 1935.

SILVERSHELL, steel motor tank lighter; built by Richard Dunston, Ltd., Thorne; to the order of Trinidad owners; dimensions, 65ft. 6in. Delivery, recent.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

E. J. ELGOOD, Ltd., inform us that they have removed to Insulcrete Works, Yeoman-street, S.E.8. Telephone number, Bermondsey 1144 (5 lines).

MR. G. W. VICKERS, general manager of the company, has been elected to a seat upon the board of the Sheffield Testing Works, Ltd., Blonk-street, Sheffield, 1.

TECALEMIT, Ltd., informs us that its Brentford works are being extended by a new bay the whole length of the works, with a floor above, which will accommodate the whole of the technical services of the company.

MR. G. H. HOLDING, late works manager of Drake and Gorham, Ltd., has joined Newman, Sons and Co., Ltd., of Yate, Bristol, and on February 1st will be opening a London office at 32, Victoria-street, London, S.W.1 (telephone number, Victoria 2023.)

HIGGS MOTORS, Ltd., Witton, have put in hand an extension of their machine shop, 25,000 square feet in area. This will be a north-lighted, single-storey building. This is the first section of a building which will ultimately cover approximately 120,000 square feet and will be completed as and when necessary.

THE ENGLISH ELECTRIC COMPANY advises us that Mr. H. S. Aspinall has been appointed deputy general manager, London and export. He will continue to act as manager of the Diesel Engine Department, and will be assisted by Mr. R. H. Green (late sales manager of Petters, Ltd.) as manager, Diesel engines sales. Both Mr. Aspinall and Mr. Green have rooms in the company's registered office, Queen's House, Kingsway, London, W.C.2.

COOPERS HILL WAR MEMORIAL PRIZE AND MEDAL.—The triennial award of the above Prize and Medal, which fell in 1934 to the Institution of Electrical Engineers, has been made by the Council to Mr. Alexander M. Wright, M.Sc., A.M.I.E.E., for his paper on "Electrification of Railways."

FRENCH HONOUR FOR AN ENGLISH FOUNDRYMAN.—The Diploma of Ingénieur de l'Ecole Supérieure de Fonderie, never before awarded to an Englishman, has been awarded to Mr. C. J. Dadswell, who in May of this year was appointed in charge of the Cammell Grimesthorpe Foundry of the English Steel Corporation, Ltd. Mr. Dadswell was educated at University College, University of London, served his apprenticeship as an engineer, and was for some time attached to the works manager's department at the London, Midland and Scottish Railway, Carriage and Wagon Works, Wolverton. In 1932 he won the Robert Blair Fellowship, the most valuable scholarship in the gift of the London County Council. This enabled him to increase his knowledge of foundry work by visiting foundries in France and Italy, and to take the specialising course for foundry executives at the Ecole Supérieure de Fonderie in Paris, one of the best-known foundry schools in the world.

NEW BRITISH CHEMICAL STANDARDS.—As a result of a request for standard analysed samples of ferro-alloys, British Chemical Standards announces the issue of the first three of a new series, viz.:—Ferro-tungsten (80·7 per cent. tungsten); ferro-molybdenum (72·1 per cent. molybdenum); ferro-titanium (22·8 per cent. titanium). These alloys are in each case of the low carbon variety and have been analysed by a ferro-alloy manufacturer, independent chemist, and Sheffield works chemists. The standard samples are issued in bottles containing 25 and 50 grms. of each alloy, at a price which it is estimated will eventually cover the cost. A certificate of analyses accompanies each bottle and records not only the individual tests and the standard figures, but gives also an outline of the methods of analyses employed. This information is of particular value in the case of the ferro-tungsten. The samples may be obtained direct from headquarters, 3, Wilson-street, Middlesbrough, or from any of the usual laboratory furnishers.

# Markets, Notes and News.

**The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.**

### Import and Export Figures.

The Board of Trade returns for December include the iron and steel import and export figures for the year, and provide some interesting information regarding our foreign trade. The total of "iron and steel and manufacturers thereof" brought into the country last year was 1,366,660 tons, compared with 970,830 tons for 1933. It was considerably less, however, than in 1932, when 1,593,555 tons were imported. On the other hand, our exports last year showed a satisfactory increase of 331,673 tons to 2,253,467 tons, the total for 1933 being 1,921,794 tons and for 1932 1,837,295 tons. It is of interest that for the past three years there has been a steady increase in the exports of iron and steel materials, whilst the imports, after falling by 622,725 tons in 1933, regained 226,895 tons last year. Imports of pig iron in 1934 reached 125,715 tons, of which 110,086 tons came from India. Blooms, billets, and slabs were imported to the extent of 330,755 tons, compared with 229,526 tons, a substantial gain last year of 101,229 tons. Belgium was the largest exporter to this country with 116,562 tons, France coming next with 111,991 tons, and then Germany with 45,800 tons. The increase in the imports last year was even more noticeable in the case of sheet bars, which reached 116,355 tons, compared with 81,435 tons in 1933. Belgium was again the largest supplier, with 91,422 tons, Germany coming next with 4939 tons. Last year 7514 tons of tin-plate bars were imported, against 3068 tons in the previous year; but in 1932 no less than 93,813 tons came in. In the case of general descriptions of steel, the imports reached 280,859 tons, compared with 186,608 tons in 1933, whilst 100,357 tons of girders, beams, joists, and pillars were imported, compared with 77,550 tons in 1933 and 69,739 tons in 1932. An analysis of the year's imports shows that Belgium easily took first place, with a total of 602,620 tons, Luxemburg being second with 173,978 tons, and Germany third with 144,564 tons. Of British countries, India contributed 126,324 tons, which consisted almost entirely of pig iron, the imports from other British countries totalling 82,817 tons.

### Expanding Exports of Iron and Steel.

The exports of pig iron, although they do not show any notable increase, were higher in 1934 than for the two previous years, totalling 123,476 tons, compared with 107,987 tons in 1933 and 121,010 tons in 1932. General descriptions of steel were exported to the extent of 173,148 tons, the previous yearly totals being 107,520 tons in 1933 and 90,331 tons in 1932. British India took the largest quantity with 29,392 tons, South Africa coming second with 28,719 tons. There was a satisfactory increase in the exports of girders, beams, and joists, from 13,879 tons in 1933 to 25,848 tons last year. Exports of hoop and strip were steady, the total for 1934 being 47,388 tons and for the previous year 47,200 tons. A notable increase, however, is registered in the exports of plates and sheets not under ⅛in., which rose to 159,641 tons last year against 87,317 tons in 1933 and 133,503 tons in 1932. There was also a satisfactory improvement in the exports of plates and sheets under ⅛in., which last year reached 140,483 tons, compared with 125,348 tons and 117,340 tons respectively in 1933 and 1932. The galvanised sheet trade has been passing through a period of depression for some time, and this year showed another reduction in the total exports to 249,066 tons, compared with 275,797 tons in the previous year. Tin-plate exports were also down, the figures being for last year 372,071 tons, against 442,343 tons in 1933 and 452,067 tons in 1932. There was a satisfactory increase of 80,893 tons in the exports of railway material, which last year amounted to 190,857 tons, compared with 109,964 tons in 1932. South Africa was the largest buyer of railway steel, with 34,914 tons, India coming next with 20,897 tons, and then New Zealand with 16,638 tons. South Africa, in fact, was the best customer to the British iron and steel industry last year, her total purchases amounting to 250,714 tons. India was second with 222,531 tons, and Australia next with 160,605 tons. Exports to Canada reached 147,640 tons. Of foreign countries, Denmark was the largest buyer, with 115,021 tons, the Argentine being next with 111,430 tons, whilst China took 104,178 tons.

### Pig Iron.

The pig iron market has provided no surprises in the opening weeks of the New Year. For the first fortnight new business was somewhat scanty; but deliveries to consumers' works were restarted after the holidays at a satisfactory rate. This week the market may be considered to have resumed normal working, and there has been a noticeable increase in the turnover. The completion of the Scottish New Year holidays naturally had some effect, as deliveries to consumers North of the Tweed were recommenced on a good scale. New business with the consuming trades in Scotland has not yet been important, but the stocks of iron which accumulated in the makers' yards during the stoppage have been reduced. Most of the light castings foundries made a good restart and expect to be busy for some months. Their requirements of Cleveland iron this week have been satisfied by deliveries against existing contracts. Business with local consumers on the North-East Coast has expanded recently, according to expectations, and the export side of the trade, also, is reported to have improved. The Wages Board ascertained average price for Cleveland No. 3 foundry for the last quarter of 1934 was not so high as had been expected. The average net realised price worked out at 57s. 4·15d., which was 5s. higher than for the corresponding quarter of 1933. The quotation for Cleveland No. 3 is 67s. 3d., delivered Middlesbrough, with 2s. extra delivered to consumers in the North-Eastern area. The prices for Scotland are 67s. 3d. delivered Falkirk, and 70s. 3d. delivered Glasgow. If anything, the development of the demand for Midland pig iron has exceeded expectations. Although the light castings foundries are irregularly supplied with work, the expansion in the requirements of the heavy engineering industry has continued on moderate lines. Deliveries have been on a good scale and during the past week a respectable amount of new business has been transacted. The hematite market has not been really active since the holidays, but a steady stream of specifications against contracts has been reaching the producers. The Midland and Sheffield consumers in particular have been taking heavy tonnages.

### British Iron and Steel Production.

THE British Iron and Steel Federation, in its monthly statement for December, reports that there were ninety-six furnaces in blast at the end of the month, the same number as at the beginning, one furnace having commenced operations and one having been blown out for repairs. Although the report does not give particulars, the furnace which was blown in was at Dorman, Long and Co.'s works and was put on to produce ferro-manganese, whilst that which ceased operating was at the Consett Ironworks, Ltd., and had been engaged on making hematite. The production of pig iron in December amounted to 513,500 tons, compared with 507,600 tons in November and 409,300 tons in December, 1933. This includes 128,600 tons of hematite, 245,300 tons of basic, 122,200 tons of foundry, and 8200 tons of forge pig iron. Owing to the Christmas holidays the output of steel ingots and castings declined somewhat, to 654,500 tons, compared with 766,000 tons in November and 668,900 tons in December, 1933. The December figures bring the total pig iron output for the year to 5,978,500 tons, compared with 4,136,000 in 1933 and of steel to 8,859,700 tons, compared with 7,024,000 tons in 1933. The following table shows the average monthly production over a period of years and the output for the past four months:—

| | Pig iron. Tons. | Steel. Tons. |
|---|---|---|
| 1913—Monthly average .. .. | 855,000 | 638,600 |
| 1920 ,, ,, .. .. | 669,500 | 755,600 |
| 1929 ,, ,, .. .. | 632,400 | 803,000 |
| 1932 ,, ,, .. .. | 297,800 | 438,500 |
| 1933 ,, ,, .. .. | 344,700 | 585,300 |
| 1934 ,, ,, .. .. | 498,200 | 738,300 |
| 1934—September .. .. .. | 500,300 | 734,700 |
| October .. .. .. .. | 527,100 | 812,000 |
| November .. .. .. | 507,600 | 766,000 |
| December .. .. .. | 513,500 | 654,500 |

### Scotland and the North.

The Scottish New Year holidays finally closed at the end of last week, and this week all departments of the steel industry have been at work. There was a fair accumulation of orders during the holiday break, and this, with the work remaining on hand when operations ceased, enabled the steel works to make a promising re-start. Although a large tonnage of orders for the shipyards on the Clyde and at Belfast have been worked off, the steel works have contracts in hand which will keep them busy for some time, and it is expected that new orders will be given out shortly. Since the New Year contracts for two passenger and cargo steamers have been obtained. The structural and marine engineering works are well employed and are taking steady quantities of iron and steel. New work for this industry, however, would be welcomed, as recently some good contracts have been completed. Satisfactory conditions rule at the locomotive and wagon works in Scotland and the former are taking good deliveries of plates. Conditions at the sheet works are expected to show some improvement this month, as the spring requirements of the motor car manufacturers and other home consumers will shortly begin to exercise an influence upon the market. The present volume of business in the heavier gauges of black sheets is satisfactory, but the thin sheet mills are not busy and this branch of the industry is suffering from the rather weak export demand. The Lancashire finished steel industries, on the whole, are starting the New Year in good circumstances, although rather irregular conditions rule in one or two departments. Some of the re-rollers are not so busy as they were before Christmas, but other establishments have more orders on their hands than they expected to commence the year with, as a fair amount of business was collected during the holiday period. The heavy steel works have a good tonnage of orders on their books, but some makers complain that new business is not coming along fast enough to satisfy them. Specifications against existing contracts are reaching the mills with regularity. In the Barrow district the works have sufficient orders to keep them actively employed during the first half-year, and considerable additions to their books are expected as a result of the railway companies' programme for 1935.

### Current Business.

The Liverpool Passenger Transport Committee have recommended the purchase of 300 new tramcars, at a cost of £550,000, and the modernisation of 162 existing tramcars, the purchase to be spread over a period of three years. Metropolitan-Vickers, Ltd., C. A. Parsons and Co., Ltd., and International Combustion, Ltd., have obtained contracts for additions to the Perth (Western Australian) electric power station, valued at £420,000. A contract for a single-screw steamer of 1350 tons d.w. has been secured by the Ailsa Shipbuilding Company, Ltd., of Troon. Vickers-Armstrong, Ltd., of Barrow, will receive the contract for the mine-laying submarine, included in the Admiralty's programme. It is reported that a tentative agreement has been reached between Scott's Shipbuilding and Engineering Company, Ltd., and the Greenock Dockyard Company, Ltd., by which the former would take over the Greenock Dockyard Company's yard and the latter Scott's Cartsdyke yard. The Greenock yard is situated between Scott's Cartsburn and Cartsdyke yards. The Import Duties Advisory Committee announces the application for an increase in the import duty on tubes of all sections manufactured wholly of copper or of alloys containing more than 50 per cent. by weight of copper. The Department of Overseas Trade announces that the following contracts are open for tender:—South African Railways and Harbours: Five 6-ton six-wheeled motor chassis, ten 12-ton motor chassis, dual-purpose motor chassis, three 4-ton motor chassis, five 6-ton four-wheeled chassis, and passenger motor chassis (South Africa, March 11th). Indian Stores Department: Wheels and axles, disc centre (New Delhi, February 25th). Singapore, Municipal Water Department: Double-flanged sluice valves, 2in. to 30in.; double-socket sluice valves, 4in. to 30in. (London or Singapore, March 4th). Siam, Royal State Railways: Mild steel rounds for reinforcement, mild steel flats, rounds, squares, angles, and sheets for rolling stock (Bangkok, March 1st); ten sets of central buffer hook cotter and nut, and thirty-two intermediate buffer guides (Bangkok, February 16th). New Zealand, Posts and Telegraphs Department: 50,000 insulator spindles and 10,000 arm bolts (Wellington, March 4th); a local firm at Wellington requires quotations from United Kingdom makers of 13 g. soft drawn galvanised wire and steel strip for stamping and cutting. South African Railways and Harbours: Five or more 2-ton and five or more 5-ton four-wheeled welded tram road trailers (South Africa, March 4th).

### Copper and Tin.

For a long time past copper prices have reflected current talk in the market of the progress or lack of progress made by the producers in negotiating for a scheme of international control. During the past week it would appear that matters have not been going very favourably, as, after showing considerable strength since the New Year opened, the market has become definitely weaker. According to reports, the Belgian Katanga interests have adopted a somewhat independent attitude at informal discussions that have taken place in London. As a result of rumours to this effect an easier tone has prevailed, and consumers of electrolytic copper have shown much less interest in the market, whilst speculators who have been expecting a sharp advance in prices directly agreement upon the scheme of control is announced have lost heart in some cases and have disposed of their holdings. As most of the copper held on speculative account was bought at prices below those now ruling, it has been possible to do so and to take a moderate profit. In the early part of the week there was a fair amount of buying by consumers, and Italy bought a quantity of rough copper for sulphate making. Efforts are still being made by Germany to arrange barter agreements which will provide her with copper, but these seem to be hanging fire. American statistics for 1934 indicate that the production of copper increased considerably in Arizona, Utah, Montana, and New Mexico. The standard market has been moderately active, but speculation has not been on anything like the same scale as during the past week or two. There has been a tendency to take profits, with the result that the undertone of the market has been on the easy side, although prices have not shown much variation. . . . The shortness of the prompt position which caused an advance in the values of tin was eased somewhat by the release of metal to meet the requirements of the market, it is assumed in some quarters by the controllers of the Buffer Pool. As a consequence, prices, after jumping to over £233 for prompt, have receded to just over £230. Opinions, however, differ as to whether the tightness in this market has been more than temporarily relieved, and in some quarters it is expected that if the American demand improves in accordance with anticipations, there will again be a scarcity of prompt metal. The stocks in this country are declining, but they are still not far short of 3000 tons.

### Lead and Spelter.

No fresh announcement has been made regarding the inquiry which the Import Duties Advisory Committee is holding into the operation of the duties upon lead and spelter. It is known that the various interests concerned are presenting their cases to the Committee. Although some uncertainty is, no doubt, felt as a result of the inquiry, it has had little effect upon trading in these markets. Speculators at any rate do not appear to have been encouraged to operate on the chance that prices will appreciate if the duties are withdrawn. The demand for lead has been steady, but business is still suffering from the after-effects of the holidays. American figures show that the world's production of lead in November sharply decreased to 123,192 tons from 130,695 tons in October. The quiet conditions which have ruled lately are not more pronounced than is usual at this time of the year, and it is not thought that they will last beyond the end of the month. The manufacturers of lead pipes and sheets are still busy, and their requirements are likely to be on a considerable scale, whilst the prospects of other lead-consuming trades are distinctly favourable. Somewhat irregular conditions have characterised the spelter market, partly owing to the late arrival of a consignment of foreign spelter. No arrivals of Empire spelter are expected until March, and consumers are finding it difficult to obtain Empire brands. A certain amount of metal, of course, exists in warehouse, but the quantities are not large. It has at length been announced that the European Zinc Cartel has been dissolved. This has had no effect upon the market as for some months it has not functioned.

# Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.: plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

## PIG IRON.

| | Home. | Export. |
|---|---|---|
| | (*D/d Teesside Area*) | |
| N.E. COAST— | £ s. d. | £ s. d. |
| Hematite Mixed Nos. | 3 8 6 | 3 2 0 |
| No. 1 | 3 9 0 | 3 2 6 |
| Cleveland— | (*D/d Teesside Area*) | |
| No. 1 | 3 10 0 | 3 4 0 |
| No. 3 G.M.B. | 3 7 6 | 3 1 6 |
| No. 4 Forge | 3 6 6 | 3 0 6 |
| Basic (*Less 5/– rebate*) | 3 7 6 | — |
| MIDLANDS— | | |
| Staffs.— | (*Delivered to Black Country Station*) | |
| North Staffs. Foundry | 3 11 0 | — |
| " " Forge | 3 6 6 | — |
| Basic (*Less 5/– rebate*) | 3 12 6 | — |
| Northampton— | | |
| Foundry No. 3 | 3 7 6 | — |
| Forge | 3 2 6 | — |
| Derbyshire— | | |
| No. 3 Foundry | 3 11 0 | — |
| Forge | 3 6 0 | — |
| SCOTLAND— | | |
| Hematite, f.o.t. furnaces | 3 11 0 | — |
| No. 1 Foundry, ditto | 3 12 6 | — |
| No. 3 Foundry, ditto | 3 10 0 | — |
| Basic, d/d (*Less 5/–rebate*) | 3 7 6 | — |
| N.W. COAST— | | |
| Hematite Mixed Nos. | 3 12 6 d/d Glasgow<br>4 0 6 " Sheffield<br>4 5 6 " Birmingham | |

## MANUFACTURED IRON.

| | Home. | Export. |
|---|---|---|
| LANCS.— | £ s. d. | £ s. d. |
| Crown Bars | 9 12 6 | — |
| Best Bars | 10 2 6 | — |
| S. YORKS.— | | |
| Crown Bars | 9 12 6 | — |
| Best Bars | 10 2 6 | — |
| MIDLANDS— | | |
| Crown Bars | 9 15 0 | — |
| Marked Bars (Staffs.) | 12 0 0 | — |
| Nut and Bolt Bars | 7 5 0 to 7 15 0 | — |
| SCOTLAND— | | |
| Crown Bars | 9 12 6 | 9 5 0 |
| Best | 10 2 6 | 9 15 0 |
| N.E. COAST— | | |
| Common Bars | 9 12 6 | 8 15 0 |
| Best Bars | 10 2 6 | 9 15 0 |
| Double Best Bars | 10 12 6 | 10 0 0 |

## STEEL.

| | Home. | Export. |
|---|---|---|
| LONDON AND THE SOUTH— | £ s. d. | £ s. d. |
| Angles | 8 10 0 | 7 7 6 |
| Tees | 9 10 0 | 8 7 6 |
| Joists | 8 17 6 | 7 7 6 |
| Channels | 8 15 0 | 7 12 6 |
| Rounds, 3in. and up | 9 10 0 | 8 7 6 |
| " under 3in. | 8 14 6 | — |
| Flats, 5in. and under | 8 14 6 | 7 2 6 |
| Plates, ¼in. (basis) | 9 0 0 | 7 15 0 |
| " ⅛in. | 9 5 0 | 8 0 0 |
| " ¼in. | 9 10 0 | 8 5 0 |
| " ⅜in. | 9 15 0 | 8 10 0 |
| " ½in. | 9 10 0 | 8 5 0 |
| NORTH-EAST COAST— | £ s. d. | £ s. d. |
| Angles | 8 7 6 | 7 7 6 |
| Tees | 9 7 6 | 8 7 6 |
| Joists | 8 15 0 | 7 7 6 |
| Channels | 8 12 6 | 7 12 6 |
| Rounds, 3in. and up | 9 7 6 | 8 7 6 |
| " under 3in. | 8 12 0 | 7 10 0 |
| Plates, ¼in. | 8 15 0 | 7 15 0 |
| " ⅛in. | 9 0 0 | 8 0 0 |
| " ¼in. | 9 5 0 | 8 5 0 |
| " ⅜in. | 9 10 0 | 8 10 0 |
| " ½in. | 9 5 0 | 8 5 0 |
| Boiler Plates, ¼in. | 9 5 0 | 8 5 0 |
| MIDLANDS, AND LEEDS AND DISTRICT— | £ s. d. | £ s. d. |
| Angles | 8 7 6 | 7 7 6 |
| Tees | 9 7 6 | 8 7 6 |
| Joists | 8 15 0 | 7 7 6 |
| Channels | 8 12 6 | 7 12 6 |
| Rounds, 3in. and up | 9 7 6 | 8 7 6 |
| " under 3in. | 8 12 0 | 7 10 0 |
| Flats, 5in. and under | 8 12 0 | 8 17 6 |
| Plates, ¼in. (basis) | 8 17 6 | 7 15 0 |
| " ⅛in. | 9 2 6 | 8 0 0 |
| " ¼in. | 9 7 6 | 8 5 0 |
| " ⅜in. | 9 12 6 | 8 10 0 |
| " ½in. | 9 5 0 | 8 5 0 |
| Boiler Plates, ¼in. | 9 7 6 .. 7 15 0 | 8 5 0 |

## STEEL (*continued*).

| | Home. | Export. |
|---|---|---|
| GLASGOW AND DISTRICT— | £ s. d. | £ s. d. |
| Angles | 8 7 6 | 7 7 6 |
| Tees | 9 7 6 | 8 7 6 |
| Joists | 8 15 0 | 7 7 6 |
| Channels | 8 12 6 | 7 12 6 |
| Rounds, 3in. and up | 9 7 6 | 8 7 6 |
| " under 3in. | 8 12 0 | 7 10 0 |
| Flats, 5in. and under | 8 12 0 | 8 17 6 |
| Plates, ¼in. (basis) | 8 15 0 | 7 15 0 |
| " ⅛in. | 9 0 9 | 8 0 0 |
| " ¼in. | 9 5 0 | 8 5 0 |
| " ⅜in. | 9 10 0 | 8 10 0 |
| " ½in. | 9 5 0 | 8 5 0 |
| Boiler Plates | 9 5 0 | 8 5 0 |
| SOUTH WALES AREA— | £ s. d. | £ s. d. |
| Angles | 8 7 6 | 7 7 6 |
| Tees | 9 7 6 | 8 7 6 |
| Joists | 8 15 0 | 7 7 0 |
| Channels | 8 12 6 | 7 12 6 |
| Rounds, 3in. and up | 9 7 6 | 8 7 6 |
| " under 3in. | 8 12 0 | 7 10 0 |
| Flats, 5in. and under | 8 12 0 | 8 17 6 |
| Plates, ¼in. (basis) | 8 17 6 | 7 15 0 |
| " ⅛in. | 9 2 6 | 8 0 0 |
| " ¼in. | 9 7 6 | 8 5 0 |
| " ⅜in. | 9 12 6 | 8 10 0 |
| " ½in. | 9 10 0 | 8 5 0 |

| IRELAND— | BELFAST. | REST OF IRELAND. |
|---|---|---|
| | £ s. d. | £ s. d. |
| Angles | 8 12 6 | 8 15 0 |
| Tees | 9 12 6 | 9 15 0 |
| Joists | 9 0 0 | 9 2 6 |
| Channels | 8 17 6 | 9 0 0 |
| Rounds, 3in. and up | 9 12 6 | 9 15 0 |
| " under 3in. | 9 2 0 | 9 4 6 |
| Plates, ¼in. (basis) | 9 0 0 | 9 2 6 |
| " ⅛in. | 9 5 0 | 9 7 6 |
| " ¼in. | 9 10 0 | 9 12 6 |
| " ⅜in. | 9 15 0 | 9 17 6 |
| " ½in. | 9 12 6 | 9 15 0 |

### OTHER STEEL MATERIALS.

| | Home. | Export. |
|---|---|---|
| Sheets. | £ s. d. | £ s. d. |
| 10-G. to 13-G., f.o.r. | 9 0 0 | 8 15 0 |
| 14-G. to 20-G., d/d | 10 5 0 | 9 0 0 |
| 21-G. to 24-G., d/d | 10 10 0 | 9 5 0 |
| 25-G. to 27-G., d/d | 11 2 6 | 9 17 6 |

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

| Home. | £ s. d. |
|---|---|
| 4-ton lots and up | 13 0 0 |
| 2-ton to 4-ton lots | 13 7 6 |
| Under 2 tons | 15 0 0 |

*Export:* £16 12s. 6d., c.i.f. duty paid India.
" £11 5s. 0d., f.o.b. other markets.
" Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2.
Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

| Billets. | £ s. d. |
|---|---|
| Basic (0·33% to 0·41% C.) | 6 12 6 |
| " Medium (0·42% to 0·60% C.) | 7 2 6 |
| " Hard (0·61% to 0·85% C.) | 7 12 6 |
| " " (0·86% to 0·99% C.) | 8 2 6 |
| " " (1% C. and up) | 8 12 6 |
| Soft (up to 0·25% C.), 500 tons and up | 5 10 0 |
| 100 tons | 5 15 0 |
| Rails, Heavy, 500-ton lots, f.o.t. | 8 10 0 |
| " Light, f.o.t. | 7 10 0 |

## FERRO ALLOYS.

| | Per Ton. | Per Unit. |
|---|---|---|
| Tungsten Metal Powder | 3/3 per lb. | |
| Ferro Tungsten | 3/– per lb. | |
| Ferro Chrome, 4 p.c. to 6 p.c. carbon | £23 0 0 | 7/– |
| " " 6 p.c. to 8 p.c. | £21 12 6 | 7/– |
| " " 8 p.c. to 10 p.c. | £21 12 6 | 7/– |
| " " Specially Refined | | |
| " " Max. 2 p.c. carbon | £34 0 0 | 11/– |
| " " " 1 p.c. carbon | £38 15 0 | 12/– |
| " " " 0·70 p.c. carbon | £42 0 0 | 12/6 |
| " " " carbon free | 10d. per lb. | |
| Metallic Chromium | 2/5 per lb. | |
| Ferro Manganese (loose) | £10 5 0 home | |
| " Silicon, 45 p.c. to 50 p.c. | £13 0 0 scale 5/– p.u. | |
| " " 75 p.c. | £18 7 6 scale 6/– p.u. | |
| " Vanadium | 12/8 per lb. | |
| " Molybdenum | 4/6 per lb. | |
| " Titanium (carbon free) | 9d. per lb. | |
| Nickel (per ton) | £200 to £205 | |
| Ferro Cobalt | 5/3d. per lb. | |

## NON-FERROUS METALS.

*Official Prices, January 16th.*

| | | |
|---|---|---|
| COPPER— | | |
| Cash | £27 16 3 to £27 17 6 | |
| Three months | £28 3 9 to £28 5 0 | |
| Electrolytic | £31 0 0 to £31 10 0 | |
| Best Selected Ingots, d/d Birmingham | £32 0 0 | |
| Sheets, Hot Rolled | £58 0 0 | |
| | Home. | Export. |
| Tubes, Solid Drawn (basis) | 9½d. | 9½d. |
| " Brazed (basis) | 9½d. | 9½d. |
| BRASS— | | |
| Ingots, 70/30, d/d Birmingham | £27 0 0 to £29 0 0 | |
| | Home. | Export. |
| Tubes, Solid Drawn, 2/1 Alloy | 8½d. | 8½d. |
| " Brazed | 10½d. | 10½d. |
| TIN— | | |
| Cash | £230 5 0 to £230 10 0 | |
| Three months | £228 15 0 to £229 0 0 | |
| LEAD: | £10 3 9 to £10 8 9 | |
| SPELTER: | £11 17 6 to £12 3 9 | |
| Aluminium Ingots (British) | £100 | |

## FUELS.

### SCOTLAND.

| | Export. |
|---|---|
| LANARKSHIRE— | |
| f.o.b. Grangemouth)—Navigation Unscreened | 13/– to 13/6 |
| " Glasgow—Ell | 16/– |
| " " Splint | 17/6 |
| AYRSHIRE— | |
| (f.o.b. Ports)—Steam | 14/– to 14/6 |
| FIFESHIRE— | |
| (f.o.b. Methil or Burntisland)—Prime Steam | 14/– |
| Unscreened Navigation | 12/6 to 13/– |
| LOTHIANS— | |
| (f.o.b. Leith)—Hartley Prime | 13/6 |
| Secondary Steam | 13/ |

### ENGLAND.

| | |
|---|---|
| YORKSHIRE, MANCHESTER— | |
| B.S.Y. Hard Steams | 18/6 to 21/6 |
| Furnace Coke | 15/– to 17/6 |
| NORTHUMBERLAND, NEWCASTLE— | |
| Blyth Best | 14/6 to 14/9 |
| " Second | 13/3 |
| " Best Small | 10/6 to 11/– |
| Unscreened | 12/6 to 13/6 |
| DURHAM— | |
| Best Gas | 14/8 |
| Foundry Coke | 18/6 to 22/6 |

| SHEFFIELD— | Inland. |
|---|---|
| Best Hand-picked Branch | 24/– to 26/– |
| South Yorkshire Best | 21/– to 23/– |
| South Yorkshire Seconds | 17/6 to 19/– |
| Rough Slacks | 8/– to 9/– |
| Nutty Slacks | 7/– to 8/6 |

| CARDIFF— SOUTH WALES. | |
|---|---|
| Steam Coals: | |
| Best Admiralty Large | 19/6 |
| Seconds | 19/– to 19/4½ |
| Best Dry Large | 18/9 to 19/3 |
| Ordinaries | 18/3 to 18/6 |
| Best Bunker Smalls | 13/6 to 14/– |
| Cargo Smalls | 11/6 to 12/6 |
| Dry Nuts | 22/– to 26/– |
| Foundry Coke | 24/– to 37/6 |
| Furnace Coke | 19/– to 21/6 |
| Patent Fuel | 21/– |
| SWANSEA— | |
| Anthracite Coals: | |
| Best Large | 37/6 to 40/– |
| Machine-made Cobbles | 41/– to 51/– |
| Nuts | 40/– to 50/– |
| Beans | 25/– to 30/– |
| Peas | 19/– to 22/6 |
| Rubbly Culm | 11/6 to 12/– |
| Steam Coals: | |
| Large | 18/– to 20/6 |

## FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

| Ex Ocean Installation. | Per Gallon. |
|---|---|
| Furnace Oil (0·950 gravity) | 3½d. |
| Diesel Oil | 4d. |

Manchester prices ½d. per gallon extra.

# French Engineering Notes.

*(From our own Correspondent in Paris.)*

### Adjustment of Output.

THE Bill providing for measures to enable industry to tide over the present crisis follows the lines laid down by the President of the Council, Monsieur Flandin. It leaves the work of organisation in the hands of those directly interested, the State intervening only to render the organisation effective by obliging minorities to accept majority decisions, while it also ensures that the operations of industrial groups are not prejudicial to the general interest. If it be found that industrial combinations are producing harmful effects, the State may dissolve them. In a word, the State will aid industrialists to carry out their methods of adjusting production to consumption, subject to the approval of an arbitration committee composed of one representative each of the production and labour federations, the commercial tribunals, the National Economic Council, and the Governor of the Bank of France, with a President chosen by the Government. The legislation will apply to industries of national importance which are in a difficult situation through the effects of the crisis, and any arrangement for adjusting production must be approved of by at least two-thirds of those engaged in the industry, or representing three-fourths of the total turnover, though this stipulation may be modified by the arbitration committee, if necessary, in order to meet special contingencies. When a particular branch of industry has organised its production with a dissident minority the State will decree that these outsiders must join the group. Those who fail to do so will be mulcted in damages for the benefit of the group, and if this action does not bring them into line with the majority their works may be closed. No one will be permitted to open new works without the consent of the group. Provision is also made for branches of industry that may not be disposed to organise output. A committee of experts will be appointed to decide in such cases the amount of reduction that may be necessary, and although the Bill is worded in a manner to suggest that the industries concerned will be obliged to conform to the recommendations of the committee, the Minister of Commerce affirms that this will not be the case. These are the main lines of the Bill for adapting industry temporarily to conditions arising out of the crisis, and it is possible that it may undergo some modification during its passage through Parliament.

### Belgian Coal Control.

A scheme similar to that underlying the Flandin Bill was put into operation on Monday of last week in Belgium, when the Office National des Charbons, comprising about eighty coalowners, and representing practically the whole coal production, was formed to supersede the Comptoir Belge de Charbons Industriels. It has arranged for a control of production during the period of the crisis, and, as is the case with the French proposal, the State will intervene by decree to ensure that a minority adheres to the convention, though dissidents will have the right of appeal to a court of arbitration which will be formed to examine minority claims. In the case of the coal trade there appears to be practical unanimity. Except for some details, the production of each colliery has been settled, and the Office National will arrange for supplies to big consumers and will fix prices. The Government will deal with coal imports in the light of recommendations from the Office National, which suggests that the imports should be reduced from 340,000 tons a month to 300,000 tons, and that the import tax on domestic coal should be 20f. a ton. The product of the tax will be utilised to maintain miners' wages. It is expected that the new arrangement will allow of a gradual absorption of stocks at pits amounting to more than 3,000,000 tons and will enable coal owners to carry on without loss during the present difficult period.

### Societe des Ingenieurs Civils.

At the meeting of the Société des Ingénieurs Civils de France on Friday last, Monsieur André Mariage was installed as President in succession to Monsieur de Fréminville. The retiring President had much to say regarding the work accomplished by Monsieur Mariage in organising the public transport service in Paris and the Department of the Seine. Monsieur Mariage joined the old Compagnie Générale des Omnibus in 1901, and in the following year was appointed chief engineer. When it was decided after the war to unify the whole of the surface transport system in Paris and the Department of the Seine, Monsieur Mariage was entrusted with the task of constituting the Société des Transports en Commun de la Région Parisienne, and in his presidential address he explained the problems that had confronted him and the manner in which they had been solved. In 1920 to 1930, he said, the number of passengers carried increased from 770 millions to 1043 millions, but on account of the crisis and the opening of new Metropolitan railway lines, the number fell to 993 millions in 1933. Three years previously it had already become apparent that the motor omnibus would prove more economical than the tramway, and with the introduction of suitable pneumatic tires, which reduced the running cost per omnibus from 80 centimes per kilometre in 1924 to 15 centimes in 1934, the superiority of the motor omnibus became so manifest, particularly with regard to speed, that the tramway was doomed. At the end of last year the Conseil Général de la Seine decided upon the suppression of all the tramways, and the surface transport throughout the Department will be effected by a new type of powerful and fast omnibus, with specially low platform. With regard to the Metropolitan Railway, the length of the system in October last was 88 miles, and 12¼ miles of new lines were under construction. The running costs are relatively low, but on account of the high cost of construction, the Metropolitan must carry daily something like 40,000 passengers per kilometre in order to realise a profit. Monsieur Mariage has always affirmed that the motor omnibus offers greater possibilities of rapid and economical town transport than a costly underground railway.

# British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

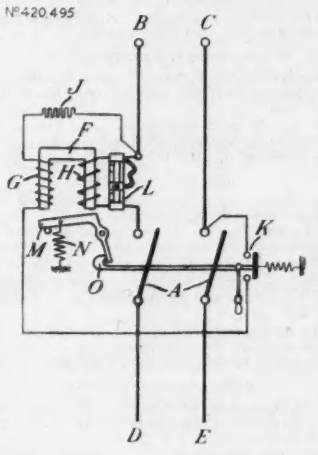
*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

### SWITCHGEAR.

420,495. July 2nd, 1934.—REVERSE CURRENT ELECTRO-MAGNETICALLY RELEASED ELECTRIC SWITCHES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.

According to this invention, the current winding of a reverse current releasing magnet is provided with a parallel resistance predominantly free from inductance. With this parallel resistance rightly chosen, at the moment of the increase of the reverse current as a result of the inductance of the current winding, the reverse current flows essentially through the parallel resistance, and the current increase per unit of time in the current winding is considerably diminished. A is a two-pole reverse current circuit breaker to the terminals B and C of which is connected a D.C. generator, and to the terminals D and E, the bus-bars on which further D.C. generators work. Co-

№ 420,495



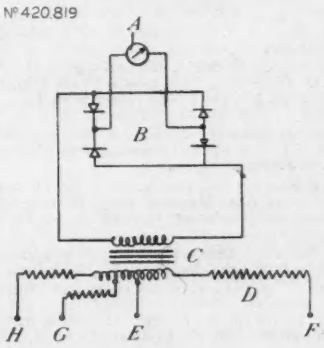

ordinated with the switch A is the reverse current releasing magnet F, on two limbs of which are arranged respectively a voltage winding G and a current winding H. Through the series resistance J and the auxiliary contact device K the voltage winding is connected direct to the generator voltage and the current winding is inserted in the course of the line from terminal B to terminal D. The ohmic resistance L with which the releasing reverse current can also be simultaneously adjusted is arranged in parallel with the current winding H. M is the magnet armature, which in the attracted condition holds the switch A in the closed position. On the occurrence of the reverse current for which the switch is adjusted to open the magnet armature M is drawn away by the return spring N and the catch O is released, so that the switch A moves into its "off" position.—*December 3rd*, 1934.

### MEASURING AND TESTING INSTRUMENTS.

420,819. May 30th, 1933.—ELECTRIC MEASURING INSTRUMENTS, *The International General Electric Company Incorporated, of 120, Broadway, New York, U.S.A.*

The consumption of current, caused in series resistances when measuring voltage, is lowered by this invention, which provides additional primary turns in the current transformer connected to additional series resistances of a value whereby the number of ampère-turns of the current transformer remains unaltered when the resistances are put in circuit for different voltage ranges. The primary current and, therefore, the consumption, in the series resistances, may be reduced, with the same secondary current being maintained in the rectifier circuit for each voltage range, by increasing the number of primary

№ 420,819



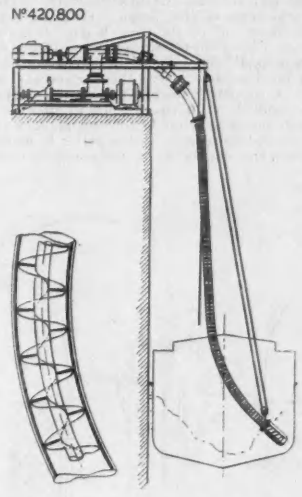

turns. The direct-current measuring means A (conveniently a moving-coil measuring instrument) and rectifiers B in Graetz arrangement are connected to the secondary winding of a current transformer C, whilst in the primary winding an ohmic resistance D is connected in series having a resistance which is a multiple of the resistance of the rest of the measuring means. The primary winding is connected through terminals E, F for low voltage ranges, and has additional turns connected through series resistances to terminals G and H, for use with higher voltage ranges. The various sections of the primary winding and the resistances between the transformer and the terminals E, G, and H are so selected that there is the same number of primary ampère-turns of the current transformer for the various voltage ranges.—*November 30th*, 1934.

### CRANES AND CONVEYORS.

420,800. August 13th, 1934.—UNLOADING CONVEYORS, E. J. L. F. Constantin, 105 rue Lafayette, Paris, France.

This invention is concerned with conveyors which must be flexible or adaptable so that they may be readily moved to the site of the material they are to convey. The conveyor is essentially of the screw type and is enclosed in a flexible tube of any

№ 420,800



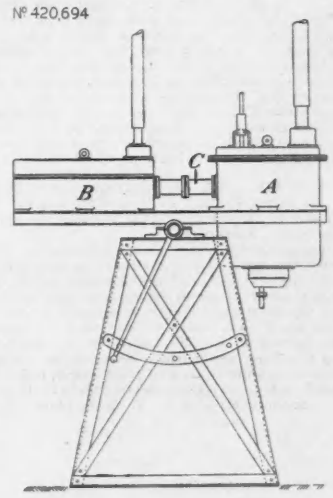
known form. The spiral flights of the conveyor extend to almost one-half of a convolution and are fixed on a flexible shaft of steel wire by a system of jamming conical sleeves. The edges of the flights do not, however, meet so closely that the flexibility of the whole assembly is impaired.—*December 7th*, 1934.

### METALLURGY.

420,694.—July 11th, 1933.—REFINING AND CASTING NON-FERROUS METALS AND ALLOYS, D. R. Tullis, Somerfield, Manor-drive, Sutton Coldfield, Warwickshire, and P. Oakley, The Tower, Rainhill, Liverpool.

This invention consists in a process for the treatment of non-ferrous metals and alloys by blowing or bubbling through the molten metal or alloy halogen in gaseous form, or a volatile

№ 420,694



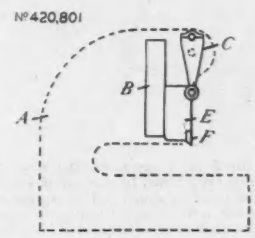

halide and/or oxy-halide, maintaining the molten metal in a non-oxidising atmosphere, the metal or alloy being cast in a mould in which a non-oxidising atmosphere is maintained, characterised in that the refining and casting of the metal are effected under a pressure in excess of atmospheric pressure. The metal is melted in the ladle A and is tilted into the mould B through the pipe C.—*December 6th*, 1934.

### MACHINE TOOLS AND SHOP APPLIANCES.

420,801. August 30th, 1933.—SHEARING MACHINES, C. J. Rhodes, Grove Ironworks, Wakefield, Yorks.

It is claimed that by adopting the form of construction shown, shearing machines for sheet metal may be made with blades as long as 16ft. As shown in the drawing, B indicates the ram, which is of L-shaped outline, A indicating generally the frame of the machine, shown by interrupted lines. C indicates one

№ 420,801

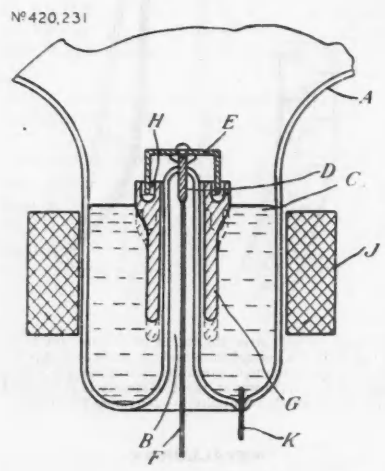



of the links by which the ram is operated, and F the knife, which is carried upon the lower end of the forward face of the portion E of the ram. The link is connected with the ram at a point, so that it is located in the plane of movement of the cutting edge of the knife. Very nearly the whole of the link C is, consequently, co-extensive, in a vertical sense, with the ram B.—*December 7th*, 1934.

## MISCELLANEOUS.

420,231. May 24th, 1933.—IGNITION DEVICES FOR MERCURY VAPOUR ELECTRIC CONVERTERS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Enrico Gallizia, of the General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

In accordance with this invention, the cathode arm of a glass bulb rectifier having an envelope A is doubled back axially and internally to form a re-entrant tube B, that extends somewhat above the level of the mercury C in the cathode arm. Through the closed top of the tube B stud D is sealed which supports a cap E and electrically connects the latter with an external conductor F. The edge of the cap extends downwardly and is at a level a little above the surface of the cathodic mercury C. A tubular plunger G of iron or other suitable magnetic material floats in the mercury around the re-entrant tube B, which serves as a guide for the plunger G, provided around its enlarged upper edge with a gutter H containing mercury into which the edge of the cap E normally extends. The




cathode arm A is surrounded by a solenoid J for controlling the plunger G. Rectifying means are provided for supplying power to the ignition device from a source of alternating current, as for example, the usual polyphase supply provided for control purposes. To ignite the rectifier, a direct-current voltage is applied between the auxiliary electrode or cap E and the cathode through the cathode connection K and a stabilising resistance, the auxiliary electrode E being connected to the positive pole of the supply, and at the same time the solenoid J is energised from the direct-current supply, with the result that the plunger G is pulled down into the mercury of the cathode. As the mercury in the gutter H recedes from the edge of the auxiliary electrode E an arc is struck, which is transferred to the mercury C of the cathode when the plunger G is completely immersed. The auxiliary electrode is used to maintain the arc which continues so long as the ignition voltage is applied between the cathode and the electrode and the solenoid is energised.—*November 26th*, 1934.

420,680. June 6th, 1933.—A FLOAT-OPERATED MECHANISM FOR ACTUATING VALVES, J. Higginson and the Autovac Manufacturing Company, Ltd., Wellington-road North, Heaton Norris, Stockport.

This invention is concerned with apparatus for supplying fuel to motor car engines by a process of suction and gravity. It comprises two levers A and B fulcrumed on parallel non-co-axial axes C and D respectively, spaced apart, the one lever A extending beyond the axis D of the other lever B, which carries the valves E and F to be operated, and the lever B extending towards the fulcrum of A. The two levers are interconnected by a spring G. The float H which actuates the mechanism is connected to the spring G, and to the lever A, either directly or by a link I thereon at a point beyond the axis D in a direction away from the fulcrum of A. With the aforesaid arrange-

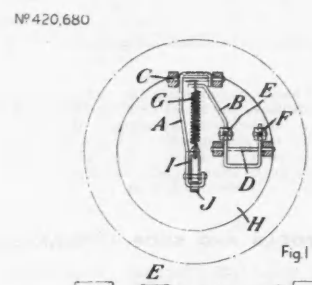



Fig. 1

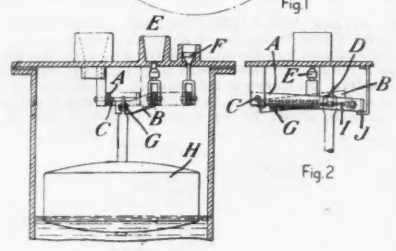



Fig. 3




Fig. 2

ment of levers, the float H can move the lever A freely from either of its extreme positions, because whilst lever B remains stationary, the radius of movement of the spring G about lever B is but slightly different from the radius of movement of the lever A, due to the proximity of the end of lever B to which the spring is connected to the fulcrum of the lever A. The spring is, however, gradually tensioned until it passes the neutral point of maximum tension, when the lever B is moved by the spring to operate the valves E and F thereon. This relatively free movement of the float H from its extreme positions is, it is claimed, of great practical importance, and very advantageous in comparison with known mechanisms in which the maximum effort of the float has to be exerted at the ends of its traverse in order to overcome the combined resistance of the spring and levers, which is then at its maximum.—*December 6th*, 1934.

# Forthcoming Engagements.

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Internal Combustion Engine Group meeting. Open discussion. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—Stafford. "The Earthquake Resistance of Structures," Mr. C. W. Hamann. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Some Notes on the Sinking of Mine Shafts through Water-bearing Strata," Mr. G. D. Breffit. 7.30 p.m.

PHYSICAL SOC.—At Imperial College of Science and Technology, South Kensington, S.W.7. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.; meeting 4.45 for 5 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "The Eastern Section of the Great Central Railway," Mr. E. B. Woodruffe-Peacock.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "Theoretical Strength of Materials and their Practical Weakness," Sir William Bragg. 9 p.m.

SATURDAY, JAN. 19TH.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN STUDENTS.—Visit to works of Bushing Company, Hebburn-on-Tyne. 2.30 p.m.

MONDAY, JAN. 21ST.

BRADFORD ENGINEERING SOC.—Technical College, Bradford. "Recent Advances in Water Purification," Mr. J. P. O'Callaghan. 7.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—At Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Graphite Lubrication," Mr. H. Higinbotham. 7.30 p.m.

TUESDAY, JAN. 22ND.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—North British Station Hotel, Edinburgh. "A Critical Examination of the Present Practice relating to the Electrical Warming and Air-conditioning of, and the Supply of Hot Water to, the Larger Buildings," Messrs. R. Grierson and D. Betts. 7 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Electron Diffraction and its Applications," Professor G. P. Thomson. 5.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Some Considerations in the Hot and Cold Rolling of Flat Stock," Mr. J. Selwyn Caswell. 7.30 p.m.

WEDNESDAY, JAN. 23RD.

INST. OF AUTOMOBILE ENGINEERS.—Engineers' Club, Manchester. "Graphite Lubrication," Mr. H. Higinbotham. 7 p.m.

INST. OF CIVIL ENGINEERS: YORKSHIRE ASSOC.—Royal Victoria Station Hotel, Sheffield. Annual dinner; reception 6.30 p.m., dinner 7 p.m.

INST. OF STRUCTURAL ENGINEERS: SCOTTISH BRANCH.—129, Bath-street, Glasgow. "A General *Resume* of Modern Architectural Practice," Mr. A. Wilson. 7.15 p.m.

NEWCOMEN SOC.—Westminster Café, 331, High Holborn, W.C.1. "Shrinking On," Mr. Rhys Jenkins; "Gaulish Fortification in Cæsar's Time," Mr. E. W. Hulme; "Lidstone's Newcomen Pamphlets, 1869–71," Mr. W. A. Young; "Donkin's Pantograph Engraving Machine," Mr. D. M. Henshaw. 4.45 for 5.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS: GRADUATE SECTION.—Bolbec Hall, Newcastle-upon-Tyne. "Exhaust Turbine in Modern Marine Practice," Mr. D. Tagg. 7.15 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Humidity, Health, and Some New Inventions," Mr. Charles L. Burdick. 8 p.m.

THURSDAY, JAN. 24TH.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. "Electrical Control of Road Traffic by Vehicle Actuation," Mr. T. P. Preist. 5.30 for 6 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "Sound-proofing Construction in Buildings," Mr. T. P. Bennett. 6.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Recent Advances in Vision and Hearing," Professor H. Hartridge. 5.15 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. Dance. 7.30 p.m. to 11 p.m.

SOC. OF CHEMICAL INDUSTRY.—Joint meeting with Nottingham Section, University College, Nottingham. "Modern Views on Polymerisation," Dr. L. A. Jordan. 7.30 p.m.

FRIDAY, JAN. 25TH.

INST. OF ELECTRICAL ENGINEERS.—Grand Hotel, Harrogate. Dinner and dance. 8 p.m.

INST. OF FUEL.—At British Industries House Club, Oxford-street, W.1. Discussion, "The Cost of Production, Transport, and Distribution, Per Therm of Various Fuels Relative to the Prices Paid by Users." 6.30 for 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "The Care of Modern Steam Generating Plant from the Water Side," Mr. R. J. Glinn. 6 p.m.

INST. OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—James Watt Memorial Inst., Birmingham. "The Deterioration of Reinforced Concrete," Mr. A. Ashworth. 6.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Some Pump Problems," Mr. W. E. W. Millington. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Mining Institute, Newcastle-upon-Tyne. "Relation of Fatigue to Modern Engine Design," Messrs. R. A. MacGregor, W. S. Burn, and Professor Frederic Bacon. 6 p.m.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Sir Richard Livingstone. 9 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "The Industrial Progress of Mysore," Mr. C. R. Rao Sahib. 4.30 p.m.

MONDAY, JAN. 28TH.

INST. OF CIVIL ENGINEERS: BELFAST AND DISTRICT ASSOC.—Physics Lecture Theatre, Queen's University, Belfast. "The Silent Valley Reservoir," Mr. G. McIldowie. 5.45 for 6.30 p.m.

INST. OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, S.W.1. "Some Deduction from Available Information on Dust Collecting," Mr. W. Lennon. 6.45 p.m.

TUESDAY, JAN. 29TH.

HULL CHEMICAL AND ENGINEERING SOC.—Municipal Technical College, Park-street, Hull. "Construction of Long-span Suspension Bridges," Professor C. E. Inglis, F.R.S. 7.45 p.m.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Prevention of Fires on Passenger Ships (Automatic Fire Fighting)," Mr. George E. Taylor. 7.30 p.m.

SHEFFIELD METALLURGICAL ASSOC.—198, West-street, Sheffield, 1. "Twenty Years' Development of the 'Analoid' System of Analyses," Mr. N. D. Ridsdale. 7.30 p.m.

THURSDAY, JAN. 31ST.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechnical Engineers, Storey's-gate, S.W.1. "Brakes for Streamlined Railway Vehicles," Mr. W. F. McDermid. 6 p.m.

INST. OF MARINE ENGINEERS: JUNIOR SECTION.—The Minories, E.C. Film display and lecture, "The Sheffield Works of the English Steel Corporation, Ltd.," Mr. C. H. Dolphin. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Modern Methods of Reinforced Concrete Construction," Mr. H. H. Broughton. 7 p.m.

FRIDAY, FEB. 1ST.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN CENTRE.—Grand Assembly Rooms, Barras Bridge, Newcastle-upon-Tyne. Annual dinner and dance. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal talk on "The Design and Erection of the Great Wheel at Earl's Court," Mr. H. Cecil Booth. 7.30 p.m.

SATURDAY, FEB. 2ND.

INST. OF BRITISH FOUNDRYMEN: LANCS. BRANCH.—Grand Hotel, Manchester. Annual whist drive, dinner, and dance.

TUESDAY, FEB. 5TH.

ILLUMINATING ENGINEERING SOC.—Trocadero Restaurant, London. Annual dinner and dance. 7 for 7.30 p.m.

INST. OF AUTOMOBILE ENGINEERS.—James Watt Memorial Inst., Birmingham. "The Utilitarian Aesthetics of Automobile Body Design," Mr. W. O. Kennington. 8 p.m.

WEDNESDAY, FEB. 6TH.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Visit to West Middlesex main sewerage and sewage disposal works.

FRIDAY, FEB. 8TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. "Centrifugally Cast Iron," Mr. J. E. Hurst. 7 p.m.

INST. OF METALS.—The University, Sheffield. "The Manufacture of Pewter," Captain F. Orme. 7.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "The Design and Equipment of Photo-elastic Laboratories, with a Brief Account of the Elements of Photo-elasticity," Professor E. G. Coker. 7.30 p.m.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "Ice Formation in Carburettors and Induction Systems," Mr. W. C. Clothier. 6.30 p.m.

MONDAY, FEB. 11TH.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. Discussion on "The I.E.E. Wiring Regulations (Tenth Edition)," Opener, Mr. H. J. Cash. 6.30 for 7 p.m.

INST. OF METALS.—At 39, Elmbank-crescent, Glasgow. "Recent Developments in Electric Furnaces for Non-ferrous Metals," Mr. A. G. Robiette. 7.30 p.m.

TUESDAY, FEB. 12TH.

INST. OF METALS.—James Watt Memorial Inst., Birmingham. Symposium on Pickling Processes. 7 p.m.

INST. OF METALS.—Armstrong College, Newcastle-upon-Tyne. "Melting Furnaces for Non-ferrous Metals," Mr. G. L. Cassidy. 7.30 p.m.

INST. OF METALS.—Y.M.C.A., Swansea. "Design of Rolling Mills for Cold Rolling of Metals, both Ferrous and Non-ferrous," Mr. C. E. Davies. 6.15 p.m.

## CONTRACTS AND ORDERS.

*The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.*

RICHARD DUNSTON, Ltd., have recently received orders from Leeds owners for a motor barge for service in the carriage of coal on Yorkshire waterways, and for three barges having dimensions 77ft. 6in. by 18ft. by 6ft. deep for London owners.

MORRIS MOTORS, Ltd., inform us that they have just received orders for industrial engines from John Birch and Co., Ltd., London, for Mawdsley's, Ltd., of Duraley; J. H. Holmes and Co., Ltd., Hebburn-on-Tyne; and John Forsythe (Terrazzo), Ltd., Belfast.

THE D.P. BATTERY COMPANY, Ltd., Bakewell, has received an order from the British Electrical and Allied Industries Research Association to supply and install a 230-volt battery, capable of discharging at 784 ampères, at the Electrical Research Association's Laboratory, Perivale, Middlesex.

THE BUELL COMBUSTION COMPANY, Ltd., 49, Moorgate, London, E.C.2, has recently received a contract from Imperial Chemical Industries (General Chemicals), Ltd., Widnes, for the supply of an Allen-Buell turbo-dryer (Büttner system) to deal with products in the form of crystals, powders, or pastes.

THE ENGLISH ELECTRIC COMPANY has been awarded a contract by the Bradford Corporation for fifteen "A.E.C.-English Electric" trollybuses, for operation on the Duckworth-lane route. These vehicles will be similar to the twenty-one supplied to Bradford during 1934. They will be of the double-deck, sixty-seater, two-axle type, the bodies being of all-metal construction.

THE PARSONS OIL ENGINE COMPANY, Ltd., Southampton, has received from Harland and Wolff an order for an emergency dynamo for a new ship for Elder, Dempster, to be launched next month, which comprises a 21 h.p. Parsons kerosene engine and a 10-kW Laurence-Scott dynamo. Another one is a 15-kW set with 24 h.p. Parsons kerosene engine and Mawdsley dynamo for the L.M.S. ship "Duke of York." Camper and Nicholsons have also placed an order for a 30 h.p. kerosene engine for driving the generator and air compressor on the yacht "Sona."

## CALENDARS, DIARIES, &c.

D. GILSON AND CO., Ltd., Billet Works, Billet-road, Walthamstow, E.17.—Wall calendar.

HARLAND AND WOLFF, Ltd., Belfast.—Wall calendar.

LANCASHIRE UNITED TRANSPORT AND POWER COMPANY, Ltd., Atherton, Lancs.—Wall calendar.

PECKETT AND SONS, Ltd., Bristol, England.—Wall calendar.

SCAMMELL LORRIES, Ltd., 52–54, High Holborn, W.C.1.—Wall calendar.

WELLMAN SMITH OWEN ENGINEERING CORPORATION, Ltd., Victoria Station House, S.W.1.—Wall calendar.